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The scheme to build a railway from the city of Mobile, down the shores of Mobile Bay, to a point which vessels of deep draft can reach, has been agitated for half a dozen years, and has come to be considered as rather a wild-cat enterprise. Latest reports in the Mobile papers, however, state that the enterprise has been taken up by English capitalists; the Secretary of War has approved the plan for the long bridge from Cedar Point to Dauphin Island; and the work is actually to go forward. Mr. T. W. Nicol, Assoc. Am. Soc. C. E., is chief engineer.

A domestic and irrigation water supply system is being developed at West Riverside, Cal., by the Raynor Springs Water Co., of Pasadena, with Mr. Jas. T. Taylor, of Riverside, as engineer. At present a tract of 1,530 acres of land is being developed. The tract has been divided into 14 blocks and these have been subdivided into 100 lots, averaging 15 acres each. The main avenues are 80 ft. and the streets 60 ft. wide, all on easy grades.

The water supply is obtained from springs, deeply driven wells and cienegas, located about 2¾ miles northwest of the city of San Bernardino, on the west side of Lytle Creek, and within the limits of the San Bernardino artesian basin, and has supplied water for irrigation and domestic purposes since 1852, when it was applied to the lands of the Mormons.

The contract for the main supply pipe, including 9,000 ft. of 16 and 26,300 ft. of 14-in., or a total of 35,300 ft. of the best quality of double riveted steel pipe, No. 14 B. W. G., weighing 3.35 lbs. per sq. ft., has been let to J. D. Hooker & Co., Los Angeles, for $28,000, and the excavation and refilling to French & Reed, Los Angeles, for $3,500, making the total cost of the main line, including a short extension of the main, some $31,500. This work is to be completed before Nov. 30, 1893. The supply main will have a carrying capacity of 4.3 cu. ft. per second, or 215 miners' ins.

A bill to permit pooling subject to the regulation of the Interstate Commerce Commission has been introduced into the House of Representatives by Mr. Patterson, of Tennessee. According to press dispatches the first section of the bill is intended to obviate the construction which the courts have placed on the words "the same line" as they appear in the present law. The courts have held that where several railways connect, constituting one line for the transaction of business, any less number forming in part the same line may charge, without violating the law, a greater rate than is charged over the entire line. This ruling would be practically nugatory of the law, and a railway could charge more over its own line than over its own and connecting lines for a much longer distance. In Section 2 the bill omits the word "pool," because of its indefinite meaning, and substitutes for it the words "any contract, agreement or arrangement," which are considered more comprehensive and definite. It further provides that railway companies may make "contracts, agreements or arrangements" for apportioning among themselves their traffic or their gross or net earnings on the conditions prescribed, and it is expressly provided that the same shall remain lawful only so long as the approval of the commission shall continue. When the commission withdraws its approval the contract, in express terms, ceases to exist, and no appeal lies. The effect is to enable the commission in its discretion to allow pooling contracts.

The letter ballot of the Master Car Builders' Association on standards of the Association closed Sept. 14 with the following results. The detailed propositions on which the vote was taken may be found by reference to the report of the June convention in our issue of June 22.

The proposition to abolish certain standards of the Association and to divide the remainder into "Standards" and "Recommended Practice" and make certain changes in their method of publication was adopted by a practically unanimous vote. The new standard drawings of journal boxes and appurtenances, the new standard for height of drawbars (34½ ins.) and the recommended practice for increasing the capacity of draft springs were all adopted by votes nearly unanimous. The recommended practice to be followed in attaching M. C. B. couplers to cars was carried by a vote of 644 to 220. The new standard drawbar yoke, stop, follower and front carrier iron, with the recommended practice for the attachment of buffer blocks were favored by a majority but failed to secure the necessary two-thirds vote. Copies of the standards may be obtained from the Secretary, Mr. John W. Cloud, Rookery Building, Chicago.

The most serious railway accident of the week was a collision due to a misplaced switch, which occurred at Kingsbury, Ind., on the Detroit division of the Wabash R. R., on Sept. 22, resulting in the death of 11 persons and the injury of 17. The wrecked train was the second section of the westbound limited express. An eastbound freight train arrived at Kingsbury at 4:20 a. m. and received orders to take the siding and wait for the passage of the westbound express, which was due at 4:40 a. m. and was running in two sections. The freight was run on the side track and the engine was then cut off and run on the main track to a water tank, and then back to its train on the siding. For these movements the head brakeman, Thompson, handled the switch, and it was correctly set for the main track when the first section passed over it at 5:10, a half hour late. The engineer of the first section gave the whistle signal to the freight engineer that another train was following, as was shown also by the tail-lights, and was answered by the freight engineer. About 12 minutes passed before the second section appeared in sight, and in that time Thompson turned the switch for the side track. When or why he did this is uncertain. The engineer of the waiting freight train thinks that Thompson turned the switch just as the train came in sight, and that he must have been asleep and have been awakened by the noise of the approaching train and then suddenly lost his head and imagined that the switch should be turned. Thompson, himself, however, before his disappearance, is said to have claimed to have known nothing about the second section, and to have thrown the switch for the freight train to pass out as soon as the first section went by, a story which, in view of the 12 minutes that elapsed between the arrival of the two sections, seems hardly probable.

The wreck occurred just before dawn when neither the switch lamp nor the switch stand itself were distinctly visible. The passenger train was running at high speed. Behind the engine were a combination baggage and smoker, two day coaches and two sleepers. The combination car and the first day coach were badly telescoped; the second day coach was swung around and none of its passengers were killed. The forward end of the first sleeper was crushed in.

The rear collision at Manteno, Ill., reported in our last issue, has been investigated by a coroner's jury, which found the flagman of the first section and the engineer of the second section guilty of criminal carelessness, and the engineer and conductor of the first section guilty of gross carelessness. The Illinois Central R. R. was also censured for "gross negligence in not providing proper signals and telegraph stations for locating passenger trains while running between Homewood, Ill., and Kankakee, Ill." It appears from the testimony at the inquest that the first section gradually lost time, and the engineer delayed too long in ordering his flagman back. When the flagman jumped off, the second section was only a half mile or so in the rear and rapidly approaching. He had not time to get more than 600 or 800 ft. back when it passed him. The engineer of the second section was keeping a poor lookout or he would have seen either the brakeman's lantern or the tail lights in time to stop.

A rather novel system of track supports is proposed by Mr. Anthony, of Sterling, Ill. Instead of cross ties he proposes to use independent blocks under each rail, resting upon a plank base to distribute the pressure. The rail will rest on an oak bearing piece set in an iron box. The gage will be maintained by iron tie rods or tie bars. Anchor blocks, set lengthwise of the track, would be bedded in the ballast at intervals and attached to the tie bars. The independent support would thus have the load of the traffic to sustain, the gage being kept by tie rods instead of by spikes in cross ties, and the line being maintained by the anchor blocks. The ballast would be filled in to the top of the "sleepers," and any settlement would be provided for by removing the oak block and placing a shim of suitable thickness in the bottom of the box. The arrangement appears somewhat complicated, but it is claimed would be advantageous in reducing the work of maintenance. In regard to safety the inventor claims that should derailed wheels get beyond the ends of the sleepers, both wheels on the axle would sink into the ballast and so tend to stop sooner than a wheel running along closely spaced ties. The result of this sudden stoppage might be less satisfactory than the inventor imagines. If a car in the middle of a train goes off the track, it is highly desirable that it bump along over the cross ties without offering too much resistance to the rest of the train. If it does encounter an obstruction, a bad wreck is pretty certain to result. The inventor will be wise if he says little concerning the merits of his system as an automatic brake. It may be said in fairness, however, that the system of independent track supports has been tried in Belgium by cutting off the worn and decayed portions of old cross ties and using two of the good pieces thus obtained, connecting them by iron bars. In India and South America, also, some thousands of miles of track have been laid with independent metal supports connected by tie rods. The inverted bowl type is perhaps the best known.

Railway earnings for July reflect the unfavorable conditions which prevailed during that month, and show a loss in both gross and net, according to the "Financial Chronicle." The statement of operations for the month is as follows:

	1893.	1892.	Dec., p. c.
Gross earnings....	$56,824,847	$59,720,176	4.85
Operat'g expenses..	40,574,200	42,179,093	3.81
Net earnings....	$16,250,647	$17,541,083	7.36

The decrease is on the whole smaller than might have been expected considering the general paralysis in business, but it is to be noted that it was not until August that business conditions reached their worst stage. In regard to the railway business in different sections of the country, the "Chronicle" says:

> Analysis of the returns for the present year brings out one very important feature. East of the Mississippi and north of the Ohio the roads evidently suffered very much less from the effects of the crisis than did the roads in other sections of the country—in fact, taken collectively, they suffered comparatively little. It is true many of these roads gained greatly in their passenger earnings by reason of the travel to the World's Fair, but that was also an influence with Western roads, even though to a less degree. The fact that the roads in the territory east of Chicago did poorly in July last year, while those farther west in many instances reported quite heavy gains, is of course also a factor in the comparisons. And yet making the allowance for all these circumstances, it is yet very evident that the troubles in the industrial and financial world have borne most heavily on the interior and remoter sections of the country.

The keystone of the south portal arch of the Baltimore Belt tunnel was set Sept. 16, practically completing the tunnel. The tunnel is 8,350 ft. long and was fully described in our issues of June 28, 1890; Dec. 12 and 19, 1891; Jan. 16, 1892, and May 18, 1893. Electric motors now being built by the General Electric Co., will be used to haul the trains through the tunnel.

The Lynn and Boston street railway system is not confined by its charter to the transportation of passengers only, as is the case with the majority of such roads. The system connects Boston and Lynn with 17 other towns, and it is now proposed that the company add to its rolling stock cars especially adapted for carrying both light and heavy goods; in other words, to introduce an express service. The plan includes a separate express company with its own cars, all of which would be impelled by electric power. These cars would be utilized for ordinary freight, baggage and market products and would relieve the highways of much heavy teaming.

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 240.)

The Latest Results at the Lawrence Experiment Station.

American cities in need of some method of sewage purification can no longer make the excuse that on this side of the Atlantic we have no practical or experimental knowledge of the subject, for, as already pointed out in these columns, some 30 municipalities are purifying their sewage, while the experimental work of the Massachusetts State Board of Health, carried on now for nearly six years at the Lawrence Experiment Station, has added vastly to the world's knowledge of sewage purification. In fact, the work at Lawrence was undertaken because of the lack of positive information regarding what might be expected from a given mode of sewage treatment, both as to results and cost of operation.

The main results of the first four years of the Lawrence experiments have already been given in Engineering News (July 11, 1891, and Dec. 15, 1892). We give below some important additional information from advance sheets of the fifth report on the work of the station, by Mr. Allen Hazen, Chemist in Charge. This information is preceded by an abstract of a paper prepared for the recent International Engineering Congress, at Chicago, by Mr. Hiram F. Mills, the engineer-member of the Massachusetts State Board of Health. Mr. Mills has general supervision of the station and his paper on "The Purification of Sewage and of Water by Filtration" embodies, to a large extent, his interpretation of the results of the Lawrence experiments.

Mr. Mills opens his paper with a review of the meager knowledge of the results to be expected from intermittent filtration at the time the experiment station was established, and presents some idea of the work done by stating that a total of 10,081 chemical and 20,650 bacterial examinations connected with sewage and water filtration have been made since the work was started.

After trying various kinds of filtering materials, including sand and gravel of different degrees of fineness and coarseness, peat, garden soil and a clayey sand and gravel, it has been found that sand is best suited for intermittent filtration and that for the very complete purification of sewage clean sand with the finer 10% of its grains equal to and less, but not much less, than 0.2 mm., or 0.008 in. in diameter, is the most favorable. Such sand in properly constructed beds 5 ft. in depth, Mr. Mills states, may be relied upon to purify 100,000 gallons of sewage per acre daily, producing a bright, clear effluent chemically as good as many drinking waters containing 0.1% of the free, and but 2% of the albmuminoid ammonia, and on the average less than 1 in 10,000 of the number of bacteria in the applied sewage. Good results can be obtained with either finer or coarser sands, but the amount of sewage applied must be diminished, while very coarse sand and open gravel is likely to become coated with slime owing to the difficulty of changing the air in its interstices with sufficient rapidity to favor complete nitrification.

An average analysis of the sewage applied to the experimental filters, expressed in parts per 100,000, is stated to be as follows:

> Loss on ignition, 20; fixed residue, 30; free ammonia, 2; albuminoid ammonia, 0.7; chlorine, 6 parts. One third of the organic matter shown by loss on ignition is in suspension. One-fifth of the mineral matter and one-half of the nitrogenous matter, as shown by the albuminoid ammonia, is in suspension. The average number of bacteria was 800,000 per cu. cm.

Mr. Mills' definition of the intermittent filtration of sewage is as follows:

> It is essentially exposing the liquid for a sufficient time in thin films upon the surfaces of solid particles having nitrifying bacteria adherent, with air in contact with the films. These are the conditions most favorable for the chemical change, which consists of burning up the organic matter and producing the harmless mineral matter which we have called nitrates. In continuous filtration these conditions do not exist, and no such purification is possible. It is equally true that the removal of bacteria from the liquid depends only incidentally upon straining.

In general the conditions most favorable to the chemical improvement of sewage also serve to remove the greatest number of bacteria, as the nitrification process burns up the organic matter and thus deprives the bacteria of food, upon which they rapidly diminish in numbers, so that in good effluents only a very small percentage of the original number remain.

The abstract of Mr. Mills' paper may be concluded by quoting a paragraph on intermittent filters, as follows:

> Study of the working of intermittent filters shows them to be not mechanical strainers, but delicate organisms gradually growing fitted to perform the work required of them, needing time to adapt themselves to any marked change in the amount or quality of the organic matter applied to them, but regularly, and for many years, performing an astonishing amount of chemical and biological purification, if the essential conditions for their action are maintained.

Passing from Mr. Mills' paper to Mr. Hazen's account of the fifth year's work of the Lawrence Experiment Station, as detailed in the forthcoming report of the Massachusetts State Board of Health, we may consider some of the practical conclusions reached during 1892.

The continued efficiency of filtration areas evidently depends largely upon the amount of organic matter stored within them. During 1892 special studies were made of the clogging of the filters. As it seemed reasonable to suppose that the small quantity of fat in the sewage played an important part in this clogging the surface sand of filters long in use the quantity of fat in the various sewage samples was determined during the year. When sewage is allowed to settle, the bulk of the fat goes into the sludge, in the form of a heavy, insoluble soap, or attached to particles of sand. At least a part of the fat remaining in the upper portion of the sewage is in solution as soap.

In March, 1892, the quantity of fat in Filter No. 6 was carefully determined and found to be 14 lbs., practically all within 2 or 3 ins. of the surface. This filter is 16 ft. 8 ins. in diameter, has a sand depth of 44 ins., and has been in use since January, 1888. Assuming that the sewage applied to Filters Nos. 1, 2 and 3 was at the same rate for the four years 1888 to 1891, inclusive, as was shown by the analyses of 1892, the approximate amounts of fats applied and stored in each of these filters during four years and some two or three months was as follows, the area of each tank being 1-200 acre:

	No. 1.	No. 2.	No. 3.
Fats applied in sewage, lbs...	234	129	136
Fats stored in sand, lbs......	16	10	14
Per cent. stored...........	6.8	7.7	10.0

From these figures, and from the results obtained in 1891 by applying soap to Filter No. 12,* it is concluded that fat does not accumulate in a filter in such a way as to choke it while remaining as a fat, although it is possible that instead of being completely oxidized and destroyed, it is oxidized to some stable compound, insoluble in ether, which clogs the sand.

In the spring of 1892 the surface sand was removed from Filters 1, 5 and 6 and piled up. In the following October determinations of albuminoid ammonia were made to determine what change had taken place in this particular. The results were as follows:

	No. 1	No. 5.	No. 6.
Days since removal............	138	200	228
Original albuminoid ammonia, parts per 100,000..............	56	23	70
Albuminoid ammonia remaining, parts per 100,000..............	44	15	53
Per cent. remaining............	78	65	76

Thus, from 22 to 35% of the albuminoid ammonia had disappeared during the spring and summer.

A portion of the clogged sand from Filter No. 6 was placed in a 20-in. filter and water applied at the rate of 51,400 gallons daily, followed later on by a change to sewage, an aspirator being used for a while to increase the available air. At first the effluent was poor, but the results improved and after five months fair work was being done. Improvement continued until finally the filter did work which compared favorably with those composed mainly of clean sand. This is explained on the basis that clogged sand acts like fine sand, and when supported by like material all goes well, but when the dirty material rests on clean the latter cannot draw water out of the dirty sand, so a saturated layer and bad results follow. When the clogged layer is made into a filter of the same material from top to bottom and sewage applied in proper quantities, the latter passes through, drawing air with it. At first that portion of the easily oxidizable clogging matter claims all the oxygen, but later some is spared to the sewage, and purification begins, increasing as the demand from the stored matter for oxygen decreases.

The aspirator mentioned above was used from May 10 to June 4 and again from June 29 to Sept. 25. Following the final removal of the aspirator there was a temporary deterioration of the effluent.

Experiments to determine the effect of various amounts of sludge in the sewage, in connection with previous knowledge on this point, have led to some interesting conclusions. From Dec. 5, 1891, to August, 1892, sewage from which a portion of the sludge had been removed by settling was applied to Filter No. 32 at the high rate of 191,300 gallons per acre per day. At the end of the nine months the surface was so clogged that good results could no longer be obtained at that rate of filtration.

In the spring of 1892 Filter No. 2 had become badly clogged, the exact cause being uncertain. Grass was sown on the sand and the dose of sewage reduced to 13,000 gallons per acre daily from March to May, then increased to 20,000 gallons June 1 and further increased in September. The reduced dose was followed by an improved effluent and in September very complete purification was obtained.

The present knowledge regarding the conditions of clogging are summarized in the report as follows:

> (1) Other conditions being the same, the clogging of a filter is proportional to the amount of sludge carried by the applied sewage; and (2) a larger proportion of the sludge of the applied sewage is stored at a high rate of filtration than at a lower rate. (3) The same quantity of matter stored causes more trouble at high rates than at lower rates. (4) The condition in which the clogged sand exists on the filter has an important influence upon the results obtained, and it is not clear that the most favorable conditions have yet been secured. (5) The clogged sand by itself becomes slowly oxidized, but to what extent is as yet uncertain. (6) The clogged sand under some conditions may serve as a filtering material with good results.

The effect of scraping filters, or removing the upper layer of sand, was tried in 1892. On June 2 sand to an average depth of 5 ins. was removed from Filter No. 2 after it had been in operation four years and five months, and had filtered 583,000 gallons of sewage, or at an average rate of 76,400 gallons per acre daily for the period. The sand removed was at the rate of 5.8 cu. yds. per 1,000,000 gallons of sewage filtered, or about 0.1% in bulk of the amount filtered. At the time of the scraping 108,000 gallons per acre daily were passing the filter with incomplete nitrification. Upon removing the upper 5 ins. of sand nitrification at once increased greatly. An examination showed that of a total of 18.68 lbs. of nitrogen in the filter, 8.73 lbs., or about 45%, were removed with the upper 5 ins. of sand. This filter was 16 ft. 8 ins. in diameter and 5 ft. deep, and contained the original material placed in it nearly 4½ years before and subjected to constant use.

Experiments were next made to determine the effect of the systematic scraping of Filter No. 9. At the commencement of the experiment, July 20, the surface had been raked weekly to a depth of about 1 in. On Sept. 9 the scum on the surface had curled up and the thickest of it was removed. In order that the full volume of sewage, 100,000 gallons per acre daily, might pass, the scraping was repeated on Sept. 20, Oct. 7 and Nov. 9. From the last date until Feb. 1, 1893, the filter continued in use without scraping, receiving its full dose of sewage. The sand was clean on May 20, 1892, and between that date and Feb. 1, 1893, there was applied a total of about 113,000 gallons of sewage and there was removed 0.95 cu. yd. of sand, making the rate of removal about 8½ cu. yds. per 1,000,000 gallons of sewage filtered. The report states that the intermittent filters which purify the sewage of Gardner, Mass. (see Eng. News, Feb. 16, 1893), are scraped with a two-day interval of applying sewage, apparently with good results.

Several pages of the report are devoted to a consideration of the effect upon purification of the stratification of the sand in a filter bed in horizontal layers of relatively fine material. Mr. Hazen's conclusions on this point are best expressed in his own words, as follows:

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*See Annual Report Massachusetts State Board of Health for 1891, p. 535.

We have found that with a coarse material above a fine one in the same filter there is a chance of trouble from a clogging of the surface of the fine material below the coarse; and this is far worse than surface clogging, for the latter can be completely remedied by disturbing the surface or by scraping. We have also found that a fine sand supported by a coarse sand will keep its lower layer saturated, and act as a water seal, allowing the passage of water but not of air, and may in this way prevent the necessary circulation of air, and reduce the action of the filter to a mere straining. Thus the possibility exists that different materials which by themselves may be suitable for the purification of sewage by intermittent filtration may be so combined in a filter that oxidation is rendered imperfect or impossible.

The above examples are perhaps extreme cases: with less marked differences in the sand sizes, or with gradual instead of abrupt transition from coarse to fine, the causes of failure might be reduced, or even in some cases entirely eliminated. In the many cases where the fields available for sewage filtration contain layers of various materials, the different sands must be separately studied, in order to determine the probable action of existing combinations; and, in case the natural conditions are unfavorabel, changes may be made which will improve the action of the filter.

Experiments were made during the year with sewage to which had been added at the station sufficient amounts of dye stuffs to strongly color the sewage. Thirteen different dyes were tried, five filters being used. From these experiments, and the observation of city sewage known to contain dye stuffs, it is concluded that intermittent filtration will remove all color given by any ordinary amount of waste dyes when diluted, as would almost always be the case, with other sewage. If the waste liquors from a mill in a practically undiluted condition should be put on a small area a high rate of filtration might or might not remove the color, according to the nature of the dyes, the amount and character of the filtering material and other conditions.

As a practical point it is urged that sewage carriers should be so constructed that the sewage will drain completely out of them when not in use and the beds so graded that sewage cannot stand in pools, as in such cases putrefaction and offensive odors are likely to result.

Regarding the area of filters to be provided in actual practice attention is called to the fact that this area should be larger than the Lawrence figures indicate, as there should be extra area for use while altering beds and, in the north, in case some of the beds become unavailable in winter through freezing. In addition the deductions above regarding the relation between the rate of filtration and the clogging of the filters by the storage of nitrogen indicates the advisability of providing sufficient area to permit a rate of filtration below the maximum.

The effect of extreme cold weather upon the intermittent filtration of sewage has been the subject of no little study and contention, and the doubts that have arisen in this connection have probably prevented the adoption of this method of sewage disposal by several communities. The winter of 1892-3 was unusually cold and the good opportunity thus afforded was taken advantage of to study the effect of severe weather upon the filter beds at South Framingham, Marlborough, and Gardner, Mass. The three places differ both in the quality of the sand used for the beds and the temperature of the sewage, as follows:

	Effective size of sand grains, 10% finer than		Ordinary minimum winter temperature of sewage
	Mm.	Ins.	F.°
South Framingham...	.32 to .42	.013 to .017	48 to 50
Marlborough.....	.12 to .14	.005 to .006	39 to 42
Gardner....	.10 to .24	.004 to .009	32 to 38

At Gardner the filtration area was limited and the sewage sometimes arrived at the filter beds at or near the freezing point, and was then at times put directly into snow, so that the beds became badly frozen and refused to do their work. At South Framingham and Marlborough the report states that the beds gave well-purified effluents. Some of the Marlborough beds were frozen and disabled, but the area being ample this was not so serious a matter as it would have been otherwise. By enlarging the doses of sewage frost may sometimes be sufficiently removed to allow sewage to pass through a frozen bed.*

Mr. Hazen comments on the winter results at the above-named places as follows:

> The results at Framingham and Marlborough demonstrate that with a sufficient area of porous material and with not too cold sewage interittent filtration can be successfully carried on in very severe winter weather, although with less complete purification of sewage than at other times. With colder sewage, however, and only limited area, the problem becomes very difficult, and the present data are inadequate for satisfactory discussion.

The sub-surface application of sewage has been tried with Filter No. 7, a 6-in. drain pipe, with open joints every 2 ft. being placed beneath, 6 ins. of brown soil resting on 10 ins. of yellow loam. This drain was embedded in and had its top at the surface of a gravel-filled trench, 2 ft. wide and 2 ft. deep, leaving 1½ ft. of sand and gravel below the pipe. The center of the pipe was 2½ ft. from the inside of the tank and the gravel was too coarse to pass through a sieve with ¾-in. mesh. From June 25, 1889, to Aug. 1, 1892, a total of 125,000 gallons of sewage, equivalent to 25,000,000 gallons on an acre, was applied to the filter without cleaning the sub-surface carriers or pipes. The pipes becoming clogged, and the free ammonia in the effluent increasing, they were dug up about Aug. 1 and found to be filled with sludge to a depth of about 4 ins. The joints were also so badly filled with sludge that apparently sewage could pass only a few of them. On cleaning and replacing the pipe the dose of sewage was increased from 17,000 gallons per acre, the rate for the first seven months of the year, to 34,000 gallons, but only a fair purification was obtained.

The total depth of filtering material in this filter is 60 ins., the 44 ins. below the loam and soil, exclusive of the gravel-filled trench, being composed of sand, 10% of which has grains finer than 0.35 mm., or .013 in., in diameter. From previous reports it appears that when sewage was applied to the surface of this filter good results were secured, but the rate of filtration was finally less than 10,000 gallons per acre. From October, 1889, with the sub-surface application of sewage, the rate of filtration was 25,700 per acre daily, with uniformly good results. Sept. 8, 1890, the rate was increased to 34,300 gallons, with fair results for a time, followed by a deterioration in the quality of the effluent, until on April 6, 1891, the rate was reduced to 17,100 gallons and remained at about this figure until the pipes began to be so badly clogged as to interfere with the action of the filter.

After cleaning the pipes the old rate of 34,000 gallons per acre was resumed, as stated above. These experiments, we may add, go to show that soil is not suited to intermittent filtration, except at an extremely low rate, and that after going to the expense of providing means for sub-surface application the rate is still low, compared with a good quality of sand, while the carriers are likely to become clogged when no precautions against clogging are taken.

THE RETURN CIRCUIT OF ELECTRIC RAILWAYS.**

By Thos. J. McTighe.

The progress of the trolley system of electric railways has been so rapid as to become almost bewildering. A multitude of improvements have been made in the track and overhead construction and the cars and power equipment, but the return circuit has been rather neglected, being largely a case of "out of sight, out of mind." Yet the return circuit is in some respects quite as important a factor of the system as the overhead circuit.

The efficiency of an electric circuit depends upon the resistance of all the parts. We carefully figure out the amount and size of overhead wire so as to bring down the waste energy in transmitting current to the motors, and we should be logically bound just as carefully to plan out the return circuit. There is this important difference, too, that while overhead we must have all copper, when we get in the ground we have a veritable tower of refuge present in the rails, if we choose to take proper steps to avail ourselves of their valuable help. Track rails are necessary, and they are getting bigger and better for our circuit purposes, and I believe that it will not be long before the absurd and costly supplementary wire for the return will have joined the vast army of discarded "expedients," and with it the earth as a permanent part of the return circuit, except in some special cases.

On a wet day, in moderate weather, the earth is available, and to a very large extent, I believe, considering that with a 70-lb. girder rail and double track we have something like 30,000 sq. ft. of earth contact per mile of track. But we cannot rely upon this doing us the same service in long spells of dry weather. Still more, we cannot rely upon it doing any good whatever in severe winter weather. It is not uncommon in this state for frost to penetrate 3 ft. in the ground, and to stay there for a whole winter. Under such circumstances the earth return must go out of our calculation. It is during severe winter weather that we want to realize our very last watt in the hard pulls we must contend with almost daily. We must also plan so as to have our return circuit efficient in the most prolonged summer drought. Ground plates and pipes laid below permanent water level are a refuge in a few favored localities, but the same can hardly be said of plates and pipes laid in the ground whose moisture depends upon the wayward elements.

I have made a large number of calculations as to what should be the total resistance per mile of the return circuit under different methods of the construction of the circuit. In making these calculations I have eliminated the conductivity of the earth, because in average winter weather the earth turns a very cold shoulder to the track. I have eliminated the conductivity of the fishplates, because I believe that under average conditions the comparatively small areas of contact surface are too much oxidized to be of much benefit.

I have based the figures on the ratio of 6 to 1 in comparing the resistance of the ordinary soft steel rails with that of our usual commercial copper, and for the latter I have followed the ordinary tables adopted by the wire manufacturers. I have not discriminated between the different assignable values for resistance in the various forms of rail bonds, and have calculated only for the specific metal used in the comparisons, leaving the merits and demerits of the form out of the question.

In studying the general situation prior to constructing, in the spring of 1891, the railway system of Lincoln, Neb. (of which my firm were supervising engineers), I investigated the subject somewhat closely. Though, at the time and under the local conditions, an advocate of iron rail bonds, I was and am yet convinced that supplementary ground wires are an unwise extravagance. I will try to give you the reasons for this belief. In steel rails we usually say that every 10 lbs. weight per yard means 1 sq. in. of cross sectional area; and every square inch of such area can be brought to terms of copper by dividing by 6. The resistance is easily determined, and we thus readily arrive at some important results for comparison. For example, take the average city railway rail as being a 70-lb. girder. Its area is substantially 7 sq. ins, and the four rails of a double track make 28 sq. ins., equal to a single steel bar 4 ins. × 7 ins. This is electrically equal to a bar of copper having 4.66 sq. ins. cross-section, or, in other words, a copper conductor 1 in. thick and almost 5 ins. wide. With such a magnificent path for our returning current, does it not seem absurd to supplement it with a No. 0 wire, whose area is that of a rod a little over ¼ in. square? But when we find the above rail resistance per mile to be but .0086 ohm, while that of the No. 0 wire is just 60 times greater, the absurdity seems to grow, and it becomes a case of sending a very small boy to do a very big man's work, with the man standing idle on the spot.

In the accompanying table a comparison is given of the results of different methods of providing for the return circuit. Of course, in localities favored all the year round with wet ground, the above table would be seriously astray, for, as I have said, the table is based upon the most unfavorable condition, namely earth frozen hard 2 or 3 ft. deep, and conductivity practically nil.

Cases 1, 2 and 11 are given as representing the system on which probably a large majority of electric railways have been constructed. A few roads have the supplementary doubled along both tracks, and a few have used slightly larger connecting wires than No. 4 B. & S. But I am trying to give the average of what has been accepted as first-class work, and will try to show it can be vastly improved. The West End and the Brooklyn City R. R. laid their tracks with double supplementary copper wires (No. 0 B. & S.), but found them totally inadequate, and now have put up many miles of huge return feeders or mains at great cost. Even these are inadequate. In Brooklyn these return mains (500,000 circular mils) are, when possible, suspended on the elevated structure. I am informed that occasionally the insulation scrapes off and the return main makes contact with the iron work. Heat enough is developed at this leak to soften the insulation for many feet, thus showing that the resistance of the main return is still too high.

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*See Engineering News, Feb. 23 and March 16, 1893, for account of applying large quantity of sewage to frozen beds at South Framingham, Mass. The last-named number also describes the filter beds at Summit, N. J., when covered with snow and ice in 1893.

**Condensed from a paper read Sept. 19 before the Street Railway Association of New York.

Now compare cases Nos. 2 and 6. The former is, no doubt, used by many members of this Association. No. 6 is the system of track circuit of the Atlantic Ave. R. R., in Brooklyn, N. Y. No. 2 has a total track resistance of .0586 ohm, and costs, for material, about $700 per mile, while No. 6 has a total track resistance of but .0130 ohm, and costs, for material, only $144 per mile. In other words, No. 6, in point of efficiency, is 4½ times better than No. 2, while costing just about one-fifth as much. In roads likely to have extreme heavy traffic, Case No. 11 has been adopted, there being four No. 0 supplementary copper wires and the ordinary copper rail bonds or connectors; being thus merely an enlargement of No. 2, and used in connection with 90-lb. rails. In Case No. 12, the 90-lb. rails are also used, but there are no supplementary wires, and each joint of the rails is supplied with two rail bonds of No. 0000 copper wire, each only 12 ins. long. Comparing results, it is evident that Case No. 12 is, electrically, about four times a better circuit than No. 11, while costing only about one-third as much.

Now let us compare No. 12, as it stands, with No. 11, but adding to the latter two 500,000 circular mils overhead returns, connected heavily to the track circuit at frequent intervals. In No. 11 the total track circuit resistance is .0306 ohm; that of the two 500,000 circular mils feeders about .0545 ohm; and the combination circuit measures about .0196 ohm. The cost of the two feeders (insulated) per mile of double track roads would be approximately $2,800, to which we add the $1,250 cost of track circuit in Case 11, making $4,050. In short, though No. 12 gives us almost three times as efficient an electric circuit as No. 11, with the two supplementary wires added, the latter costs almost 10 times more than No. 12. And yet the West End and Brooklyn City R. R. companies pin their faith to a circuit like No. 11.

Resistance, Loss of Energy, etc., of Return Circuits of Various Forms per Mile of Double Track.
(70-lb. rail is assumed in each case, except 11 and 12, where 90-lb. is assumed.

Case.	Make-up of return circuit.	Total resistance of: Rails. Ohms.	Rail Bonds. Ohms.	Track circuit. Ohms.	Fall of potential. Volts.	Loss of energy in track circuit. Watts.	Cost of loss p'r year @ $100 per K W.	Apprx. cost of track circuit material.
1	No. 4 copper bonds, connectors and 2 No. 0 copper supplementaries	.0086	.0335	.0362	7.24	1,448	$144.80	$700.00
2	No. 4 copper connectors to rail ends, 2 No. 0 copper supplementaries	.0086	.0671	.0586	11.72	2,344	234.40	700.00
3	36-in. No. 0 iron bonds single No supplementary	.0086	.0796	.0882	17.64	3,528	352.80	90.00
4	36 “ “ 0 “ double “	.0086	.0398	.0484	9.68	1,936	193.60	180.00
5	36 “ “ 0 copper bonds, single “	.0086	.0133	.0218	4.36	872	87.20	180.00
6	12 “ “ 0 “ “ “	.0086	.0044	.0130	2.60	520	52.00	115.00
7	36 “ “ 00 “ “ “	.0086	.0105	.0191	3.82	764	76.40	200.00
8	12 “ “ 00 “ “ “	.0086	.0035	.0121	2.42	484	48.40	130.00
9	36 “ “ 000 “ “ “	.0086	.0083	.0169	3.38	676	67.60	220.00
10	12 “ “ 000 “ “ “	.0086	.0027	.0113	2.26	452	45.20	150.00
11	No. 4 copper connectors to rail ends, four No. 0 supplementaries	.0067	.0335	.0306	6.12	1,224	122.40	1,250.00
12	12-in. No. 0000 copper bonds, double. No supplementary	.0067	.0011	.0078	1.56	312	31.20	432.00

A glance at the sixth and seventh columns of the table is rather instructive. If we take a medium city system operating 20 miles of double track, the company which uses No. 2 will pay several thousand dollars per year for the energy wasted in the return circuit, while the company using No. 6 or No. 8 or No. 10 will pay but a trifle in comparison and save nickels by the quart. I am of the opinion that it would, to-day, well repay any company using copper supplementary wire to rebond its tracks on a basis of perennial low resistance, because, on the average, it would save the cost of such change in one year. And I say the same to those using iron rail bonds.

The corrosion of the rails by electrolytic action when the earth is relied on to form the major part of the return circuit is another reason for reducing the resistance of the return. While the flow of the current to earth and the resulting corrosion cannot be entirely prevented, it can be reduced to a minimum by increasing the conductivity of the circuit; and it might also be retarded by dipping the rails before laying, as is done with gas and water mains. In abandoning as much as possible the rather uncertain supposed advantages of the earth return, we would to a corresponding degree rid ourselves of troubles with gas and water pipes and telephone circuits, and yet would be as safe from lightning as we are at present.

The author then discussed the different forms of rail bonds, and favored a bond made solid, in one piece, consisting merely of a wire bent into curves at the ends to permit free expansion, and having each end swayed into the form of a rivet. A hole is drilled in the rail and the rivet is put in and headed down. If the heading is properly done, the connection will be perfectly water-tight, air-tight and proof against pounding and vibration. There is no solder required, no parts to shake loose, and there is no restriction in size of wire.

I suppose the great majority of rail bonds used span around the fishplates, which nowadays are quite long. I believe this is a mistake. The table shows what a difference there is in resistance in the track circuit between 36-in. and 12-in. bonds. The 12-in. bond has the advantage in the total track resistance of from 40% to 50%. A 12-in. solid bond, with its expansion curves, makes a distance between rivet centers of about 8 ins. Electrically considered, it does not matter what part of the rail end is used for bonding. The holes can be drilled through the foot of the rail 4 ins. from the end, just as readily as through the web or stem. In girder rail I prefer to drill the holes through the foot, taper ream the holes from above, and deeply countersink; then pass the rail bond up from beneath, and head up the ends till the taper and countersink are completely filled. This method has the great advantage of allowing every rail bond to be inspected at any time without disturbing the paving. The tracks of the Atlantic Avenue R. R., in Brooklyn, were bonded in this way with No. 000 copper bonds, 8 ins. long between rivet centers, and they have given entire satisfaction.

Rail bonds should, after being applied, be either heavily coated with shellac and asphaltum, as practiced by Mr. Wason, in Cleveland, or have a grooved strip of wood filled with asphaltum slipped around while the compound is soft. This will prevent corrosion.

Another important element of the return circuit, in such roads as do not pass the power house, is the main return. Whether earth circuit is used or not, there should be a heavy connectioin from the generator or switchboard by the shortest route to the rails. Such a course is generally adopted, but the size of the conductor is apt to be too small. I have seen several cases of serious inadequacy in this direction, so much, indeed, as to heat the main return. I had occasion once to discuss the question with a gentleman who called himself an electrical engineer, and who had engineered several railways of considerable size. The problem was to return a possible maximum of 5,000 amperes about half a mile from tracks to generator. I gave my views, which embodied rather heavy work, and also my calculations for loss of energy, etc. "Nonsense," said he, "four No. 0000 wires would be abundance, because you can lay them in the ground, and the heat will be carried off before harm can be done." It was no use arguing against that; and I utterly failed to persuade him that his four wires would require 320 volts to drive the 5,000 amperes through them, i. e., a loss of over 2,100 E. HP. Fortunately that engineer has generally had some check on him, and thus the construction of several monstrosities has been avoided.

The old rails can be advantageously used for the main return in many cases. When it comes to using a large number of heavy copper wires overhead or underground on the one hand, and on the other hand an equivalent capacity of old rails laid underground, the latter are much cheaper, and can be made entirely durable. The rails can be connected by heavy copper plates by riveting, the number of rivets being equal in carrying capacity to that of the rail and plate. The whole structure can be laid in a wooden trough filled with pitch, and will remain intact for an indefinite period. A one-rail line of this kind, composed of old 60-lb. rail, is as good as a copper bar 1 in. square, or six No. 0000 copper wires.

I am, therefore, led to the conclusion that the best return circuit is that which complies with the following requirements:

1. Intrinsic resistance low enough to need no help from earth. 2. Utilization, to the utmost practical extent, of the rails as the return conductors. 3. Rail bonds of the heaviest practicable size. 4. Rail bonds of the shortest possible length consistent with due allowance for expansion and vibration. 5. Rail bonds made of a single piece of wire with integral rivets. 6. Rail bonds tightly riveted to the rails through holes freshly reamed immediately before bonding. 7. Rail bonds so placed as to permit convenient inspection. 8. Rail bonds protected against corrosion. 9. A very liberal use of heavy cross bonds from rail to rail direct, and, in double track, extra heavy cross bonds connecting the two inside rails. 10. An underground main or trunk return from power house to track, and there connected to each line of rails, and low enough in resistance to carry the maximum current with but a nominal drop in potential.

Not one of these requirements is an extravagance, but, on the contrary, their proper application to almost any electric railway in the country would be of immediate and lasting benefit. In new construction they would be a positive economy in first cost. There is not one of them which cannot be adopted in practice, and it seems obvious that their complete embodiment in any existing road would be immediately noticeable in the power house, and eventually in the dividend.

THE USES OF LOGARITHMIC CROSS-SECTION PAPER.

By W. F. Durand,* M. Am. Soc. M. E.

The last few years has witnessed a marked growth in the use of various mechanical aids to computations for engineering purposes. Such aids may be divided into four general classes:

(1) Tables of areas, volumes, powers, moments, logarithmic and circular functions, etc. (2) Slide rules of one form or another rendering the use of a table of logarithms a mechanical process. (3) Adding machines which, by various means, may be also used for subtraction, multiplication or division. (4) Graphical representation, showing by means of straight or curved lines various relationships between quantities involved in engineering research.

The curves of Class (4) are in fact simply graphical representations of tables, and as such are closely related to Class (1). Class (4) has been much extended of late, and we find an especial value in such representations from the fact that by a single line or by a few lines the results expressed in an entire table may be brought at once before the eye, and in a form sufficiently accurate for most engineering purposes.

The production and use of such graphical aids has been, however, much hampered by the fact that as plotted on ordinary cross-section paper the lines which express the tables in more common use are curved, and must be plotted point by point from a table previously computed. It is only where the exponents involved in the relationship are unity that the line becomes straight and may be drawn immediately on the determination of two of its points.

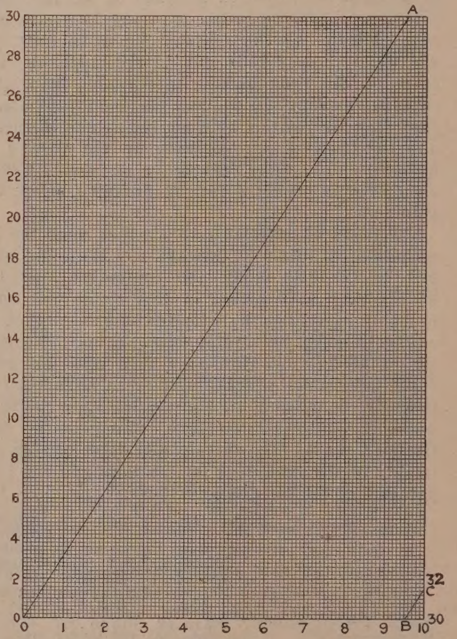

Fig. 1.

Thus, for example, the relation between the diameter of a circle and its circumference is expressed by the equation: $\text{cir.} = \pi d = 3.1416 d$. This relationship is readily expressed on ordinary cross-section paper by a straight line drawn through the origin and any other point which may be determined. In fact it must be so drawn that the tangent of the angle of its inclination to the axis on which diameters are laid off is equal to π. Such a line is in itself a table of circumferences. This is illustrated in Fig. (1). It is evident for any diameter between 0 and 10 that the circumference is read off directly from the scales as marked. For diameters between 10 and 100 the same line is used, but each unit is considered of the next higher order. Thus, for diameter 6.5, the circumference is 20.4, while for 65 it is read as 204, and similarly for other values of the diameter greater than 100. Similarly also for values less than 1 we use the same line and consider each unit as of the next lower order. Thus, for $d = .65$ we have cir. $= 2.04$, and similarly for other values.

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If now we pass to other relationships, such as, for example, the area of a circle in terms of its diameter, the representation is by no means so simple, for the line now becomes curved, and its whole course must be plotted point by point from a previously computed table.

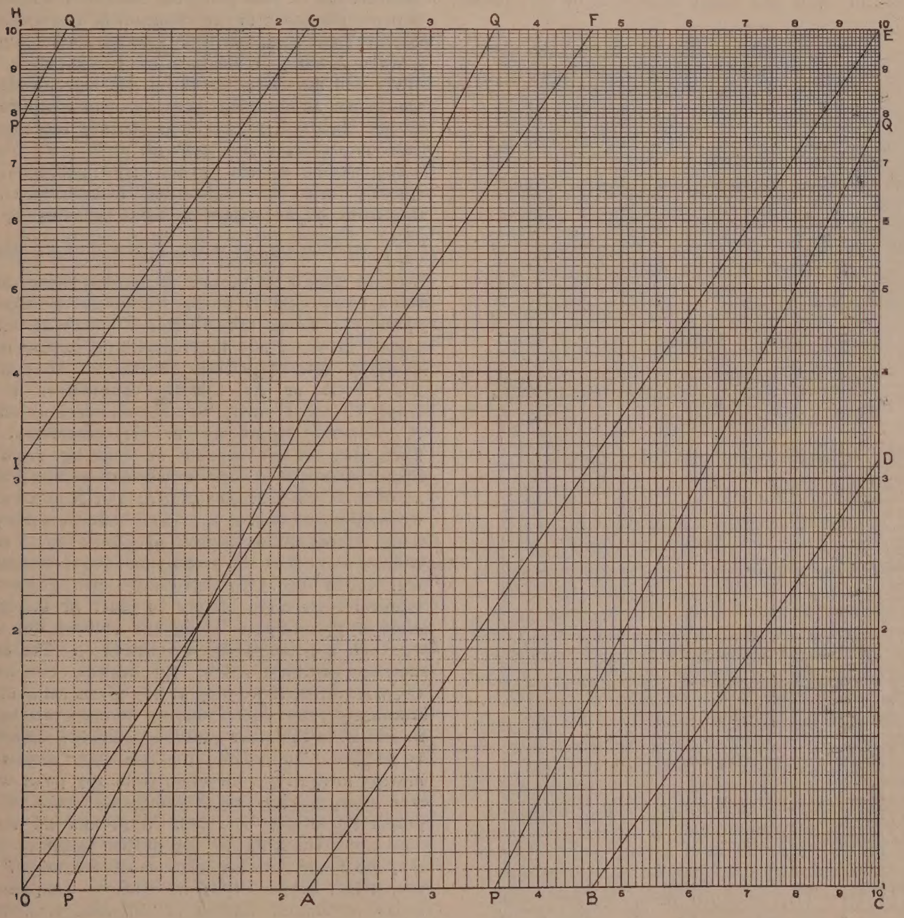


FIG. 2.

Now, it is the peculiar property of logarithmic section paper that for all relationships which involve multiplication, division, raising to powers, or extraction of roots, the lines representing them are straight. This may be readily proved as follows:

Any such relationship may be represented by an equation of the form: $y = Bx^n$. Taking logarithms we have: $\log. y = \log. B + n \log. x$. Suppose we proceed to lay off this equation on ordinary cross-section paper. We lay off log. x horizontally, and at the point so determined we lay up parallel to the axis of Y a distance B above the origin and inlay off a constant plus n times the abscissa. This gives at each point the value of log. y, and the result will be a straight line. This may be the more readily seen by noting that it is exactly similar in operation to the plotting of $y = B + nx$, a form of equation which gives a straight line cutting the axis of Y a distance: $\log. B + \log. x$. That is, we clined to the axis of X at an angle whose tangent is n. Similarly for the equation in question, the result will be a straight line cutting the axis of Y at a distance log. B above the origin, and inclined to the axis of X at an angle whose tangent is n.

Now, logarithmic section paper is simply a short and ready means of plotting such logarithmic equations. The scales on each side are logarithmic instead of uniform, as in ordinary cross-section paper. The numbers and divisions marked are placed at such points that their distances from the origin are proportional to the logarithms of such numbers instead of to the numbers themselves. It follows that if we take any point, as 3, for example, on such a scale, the real distance we are dealing with is log. 3 to some particular base, and not 3 itself. With such scales, then, we may proceed to plot numbers in the usual way, knowing that in so doing we deal with the logarithms of the numbers instead of with the numbers themselves. In general we may remember that any scale involves two distinct parts:

(1) The divisions marking off certain distances from the origin.

(2) The numbers marking such divisions.

If both of these correspond, we have the ordinary plain scale or scale of equal parts. We may, however, have the numbers mean one thing and the distances another, in any desired relationship one to the other. Thus, we might have the distances uniformly spaced, while the numbers might give the squares of such distances from the origin. Or, vice-versa, we might have the distances give the squares of the numbers. In a similar manner on the logarithmic scale the distances give the logarithms of the numbers. It should be noted that the number at the origin of such a scale is always 1 and not 0. This is, of course, because 1 is the number whose logarithm is 0. This 1 may, however, represent a unit of any order, so that quantities of any size whatever may be dealt with. Those familiar with the slide rule will note the identity between the foregoing considerations and those which underlie the use of that instrument.

It appears, therefore, if we have a series of values of x and of Bx^n, and plot on logarithmic section paper x horizontally and Bx^n vertically, that the actual distances involved will be log. x and log. (Bx^n), or $\log. B + n \log. x$. But these distances, as we have seen, will give a straight line as the locus. Hence all relationships expressible in this form are represented on logarithmic section paper by straight lines. It follows that the entire locus may be determined from any two points; that is, from any two values of Bx^n; or, again, by any one point and the angle of inclination; that is, by one value of Bx^n and the value of n, remembering that n is the tangent of the angle of inclination to the horizontal.

We will next proceed to some details of the considerations involved, and show how a single square plotted on each edge with a logarithmic scale from 1 to 10 may be made to serve for any number whatever from 0 to ∞. To make the illustration simple we will take the case of a table of $\frac{3}{2}$ powers. That is, we wish to express graphically the locus of the equation: $y = x^{\frac{3}{2}}$. Let Fig. 2 denote a square cross sectioned with logarithmic scales, as described. Suppose that there were joined to it and to each other on the right and above, an indefinite series of such squares similarly divided. Then, considering, in passing from one square to an adjacent one to the right or above, that the unit becomes of next high order, it is evident that such a series of squares would, with the proper variation of the unit, represent all values of either x or y between 0 or a quantity indefinitely small, and ∞ or a quantity indefinitely large.

Suppose next the original square divided on the horizontal edge into 3 parts, and on the vertical edge into 2 parts, the points of division being given at A, B, D, F, G, I. Then lines joining these points, as shown in the diagram, will be at an inclination to the horizontal whose tangent is $\frac{3}{2}$, and will be, therefore, in the right direction. Now, beginning at 0, it is evident that 0F will give the value of $x^{\frac{3}{2}}$ for values of x from 1 to that denoted by HF, or 0B, or about 4.6. For greater values of x the line would run into the next adjacent square above. Now, the location of this line if continued, may be seen to be exactly similar to that of BD in the square before us. It follows, therefore, that considering the units as of next higher order, the line BD will give values of $x^{\frac{3}{2}}$ for x between B and C, or 4.6 and 10. For larger values of x we consider the unit on x as of next higher order, and note that we should again run into an adjacent square to the right without change of unit for y. In this square we should traverse a line similar to IG. Therefore, by a proper choice of units we may make use of IG for the determination of values of $x^{\frac{3}{2}}$, where x lies between 10 and the value at G, or about 21.5. We should then run into an adjacent square above, requiring the unit on y to be of the next higher order, and traverse a line similar to AE, which takes us finally to the opposite corner and completes the cycle. Following this, the same series of lines would result for numbers of succeeding orders.

A little consideration of the subject will show that the value of $x^{\frac{3}{2}}$ for any value of x between 1 and ∞ may thus be read from one or another of these lines; and if for any value between 1 and ∞ then likewise for any value between 0 and 1. The location of the decimal point is readily found by a little attention to the numbers involved. A rule for its location might be derived, but is of little additional value in practice. The limiting values of x for any given line may be marked on it, thus enabling a proper choice to be readily made. Thus, in Fig. 2 we mark 0F as 0—4.6; BD as 4.6—10; IG as 10—21.5, and AE as 21.5—100. If values of x less than 1 are to be dealt with, we readily see that AE will serve for values of x between 1 and .215; IG for values between .215 and .1; BD for values between .1 and .046, and 0F for values between .046 and .001.

The principles involved in this case may be readily extended to any other, and it will be found in general that if the exponent be represented by $\frac{m}{n}$, the complete set of lines may be drawn by dividing one side of the square into m and the other into n parts, and joining the points of division as in Fig. 2. In all there will be $(m + n - 1)$ lines, and opposite to any point on X there will be n lines corresponding to the n different beginnings of the nth root of the mth power, while opposite to any point on Y will be m lines corresponding to the different beginnings of the m^{th} root of the m^{th} power. Where the complete number of lines would be quite large, it is usually unnecessary to draw them all, and the number may be limited to those necessary to cover the needed range in the values of x.

If, instead of the equation $y = x^n$, we have a constant term as a multiplier, giving an equation in the more general form $y = Bx^n$, or $\overset{m}{B}x^n$, there will be the same number of lines and at the same inclination, but all shifted vertically through a distance equal to log. B. If, therefore, we start on the axis of Y at the point B, we may draw in the same series of lines and in a similar manner. In this way PQ, Fig. 2, represents the locus giving the values of the areas of circles in terms of their diameters, being the locus of the equation $A = \frac{1}{4} \pi d^2$ or $y = \frac{1}{4} \pi x^2$.

If in any case we have x in the denominator such that the equation is in the form $y = \frac{B}{x^n}$, we note that this is equal to $y = Bx^{-n}$ and that the same general rules hold. The lines in such case simply slant downward to the right instead of upward. As an instance of this we may take the equation $pv^{\frac{10}{9}} = C$, a formula well known to the steam engineer. This in another form is $p = Cv^{-\frac{10}{9}}$. In Fig. 3 we have a line PQ drawn at an inclination whose tangent is $-\frac{10}{9}$, and which therefore readily gives the value of $v^{-\frac{10}{9}}$. We thus find the resulting value of p, and by this means a curve for this law may be laid down with almost the same ease as that for the more commonly assumed law $pv = C$.

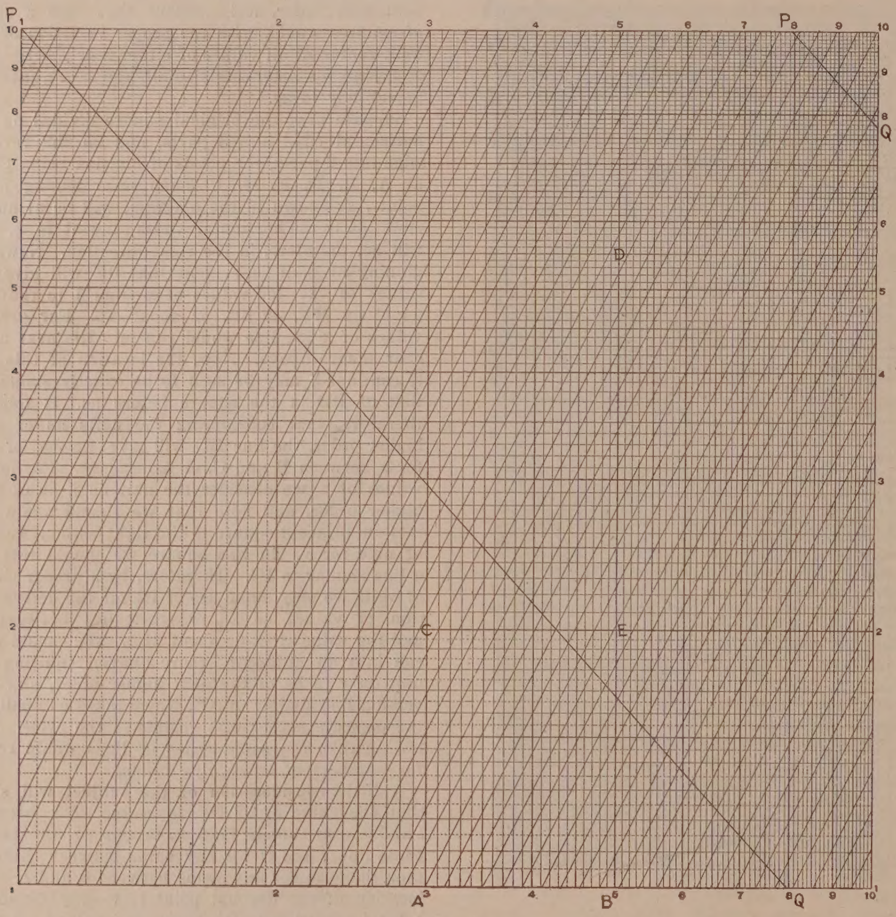


FIG. 3.

The same problem may be differently treated thus: We have $pv^{\frac{10}{9}} = p_1 v_1^{\frac{10}{9}}$ or $p = p_1 \left(\frac{v_1}{v}\right)^{\frac{10}{9}}$. Now, if the operation under consideration is an expansion, we have $v > v_1$ and $\frac{v}{v_1} = r$, the expansion ratio. Hence $p = p_1 r^{-\frac{10}{9}} = p_1 + r^{\frac{10}{9}}$. If the operation is a compression, then $v < v_1$ and $\frac{v_1}{v} = r$, the compression ratio. This gives $p = p_1 r^{\frac{10}{9}} = p_1 + r^{-\frac{10}{9}}$. Either of these values may be treated by means of a line inclined at an angle whose tangent is either $-\frac{10}{9}$ or $+\frac{10}{9}$.

The applications of this paper thus far mentioned have been concerned chiefly with quantities involving powers and roots. It must not be supposed, however, that it cannot be as readily used to express relations involving only the first power. Here, however, it has no especial advantage over ordinary paper, for with each the locus in such case is a straight line. With logarithmic paper we may note that the direction of the line in such case is always at an angle of 45°, cutting, of course, the axis of Y at a distance above the origin equal to the logarithm of the constant term.

Among the various relationships which may be represented by the means above discussed, the following may be mentioned as those more frequently occurring: Circumferences and diameters of circles in terms of their radii or diameters, or the inverse; moments of inertia and radii of gyration in terms of a linear dimension, or the inverse; length of pendulum and time of oscillation; powers and roots of any and all indices; weights of a series of bodies of the same substance and form but of varying size, in terms of a linear dimension, or the inverse; sizes of shafts, struts, tiebars, etc., in terms of varying load, or the inverse; shearing stress, bending moment, or deflection of beams in terms of load, or the inverse.

It will be noticed in the above that we have mentioned both the direct and the inverse relationships, and this is one of the advantages which all such modes of representation possess, rendering estimation and interpolation equally easy in both directions.

Many other applications might be mentioned, and each branch of engineering would furnish a large variety of uses adapted to the peculiar problems arising in such special field. In this way numerous applications will be found in the various laws of thermodynamics, in the laws relating to electricity and magnetism and electrical engineering in general, in hydraulics, in naval architecture, etc. In engineering work of an experimental character, and in various fields of physical research, special advantage will be found in the use of this form of section paper for the plotting of results.

Where, for example, it is desired to plot a result y which varies as some unknown power of a variable x, this method will be found very useful. The equation assumed to be fulfilled will be of the form $y = Bx^n$, where B is a constant and unknown, and n is unknown and may be either constant or variable. If it is constant the line will be straight, and the tangent of its inclination to X will equal n, while the distance from the origin to where it cuts Y will be equal to log. B, and will therefore determine B directly by the reading at that point. If n is not constant then the locus will be curved, and the instantaneous exponent of the variation of y with x is given by the value of the tangent of the inclination of the tangent line to the curve at such point. It may be remarked in such case that we have really to deal with two exponents, one giving the instantaneous exponent as noted above, and the other an exponent such that it will satisfy the equation $y = Bx^n$. Unexpected though it may seem, these two exponents are not the same, but both may be readily found by a proper examination of the resulting locus. For further information on this point the reader is referred to a paper published in the "Journal of the Society of Naval Engineers," on "The Analysis of Certain Curves Arising in Engineering Investigation."

We will next examine the use of logarithmic section paper as an actual instrument of computation, rather than as a means of graphically representing various algebraic relationships.

Proportions of the form $y_2 : y_1 :: x^n_2 : x^n_1$, frequently arise in engineering investigations. In the form of an equation this becomes $y_2 = y_1 \left(\frac{x_2}{x}\right)^n$ whence log, $y_2 = \log. y_1 + n (\log. x_2 - \log. x_1$. Now in Fig. 3 let A and B denote the points x_1 and x_2, and C and D be at the heights denoted by y_1 and y_2. Then, remembering that the actual distances involved are the logarithms of the corresponding quantities, we readily see that BD = AC + nAB or AC + nCE. Therefore, a line from C to D will be at an inclination to X whose tangent is n. If, therefore, we have any ready means of passing from C, a point determined by the co-ordinates x_1 y_1, along an oblique line inclined to the axis of X at an angle whose tangent is n, it is evident that we shall pass along a continuous series of points x_2 y_2 so related to x_1 y_1 that the proportion above mentioned will be fulfilled. To solve any such proportion, therefore, we have simply to start at the given point, x_1 y_1, and pass along the oblique line until we reach a point whose abscissa is x_2. The corresponding ordinate will be the desired value of y_2, Or, vice versa, if we stop at any given value of the ordinate y_2, the corresponding abscissa will be x_2. so related to the other quantities that the proportion is fulfilled. To provide the necessary means for moving in the right direction from any point whatever as x_1 y_1, a series of equidistant lines at the proper angle may be ruled. With this aid a very close approximation to the proper values of x_2 y_2 may be made. As an instance of the use of this proportion, suppose that we wish to compare the areas of similar figures of different size. Such areas are in the ratio of the squares of their linear dimensions, and a corresponding series of oblique lines will be at an inclination whose tangent is 2. Now, suppose we have given any one area which we denote by y_1, and the linear dimension x. Then, using any convenient units we note the point so determined, and passing thence along the sheet parallel to the oblique lines we shall find corresponding to any linear dimension x_2 the corresponding area y_2, or, vice versa, corresponding to any given area y_2, the corresponding linear dimension x_2.

Reference has been already made to the similarity in fundamental principle between logarithmic section paper and the slide rule. This similarity is only to be expected from the fact that the fundamental scale is the same in both. We may, therefore, expect to find in the section paper all the inherent properties of the slide rule, and in fact it may be used as such, provided only that we may be able to take the necessary mechanical advantage of them. Having in this case no slide to serve as a carrier of logarithms from one part of the scale to another, we may substitute for it a pair of dividers. By this means we find that we can perform all ordinary operations quite as readily as with the slide rule. We note that with one point of the dividers on the axis X we may reach vertically upward to any number y. The distance between the points will be log. y. If we then swing the dividers down to the right we shall add log. y to log. x, and the number at the right hand point will be the product xy. If instead, we swing to the left, we shall subtract log. y from log. x, and the number at the left hand point will be the quotient x ÷ y. This may be kept up indefinitely, and the result of any continued multiplication and division thus found. Again, if on either of the scales the two points are opened to two numbers, x and y, the distance between them will be the log. of their quotient, and placing one point at the origin we read off the quotient at the other.

We may also remember with advantage that so far as the digits in a result are concerned, the addition or subtraction of a logarithm is the same as the subtraction or addition of the complement of the logarithm. If, therefore, in any of the above operations either point of the dividers should go off the scale, the result may be found by taking advantage of this principle. To illustrate this point suppose that we wish to multiply 82 by 36. With one point of the dividers at 82 we reach up to 36 and then find on swinging to the right that the point comes off the scale. We obtain the correct result, however, by subtracting from 82 the distance from 36 to the right hand end of the scale, this distance being the complement of the log. of 36. A little familiarity will enable such occasions to be foreseen, and the complementary log. would be taken at the start. The same principle may be utilized to avoid opening the dividers to more than half the length of the scale, and a little attention to this matter will keep the distances involved down to a minimum. In the preceding example the preferable course would be to step from 82 to the right hand end of the scale and then subtract this distance from 36.

Rules for the location of the decimal point are, of course, the same as for the ordinary slide rule. For powers and roots it is preferable to have sheets ruled with a line giving the desired power or root at a glance. If this is not at hand, however, a power is readily found by simply stepping off the log, to the right or its complement to the left, as many times as there are units in the index. Thus, to cube 13 we open from 10 to 13 and step this distance three times along the scale, reading off at the end the cube desired. To cube 8 we would preferably open from the right hand end to 8, and step this distance three times to the left. To find a root, an inverse operation is necessary, remembering that there are as many different beginnings to a root as there are units in its index, and that the successive ratio between these is the nth root of 10.

We have thus outlined some of the uses of section paper ruled to logarithmic scales, where rapid approximate results are desired.

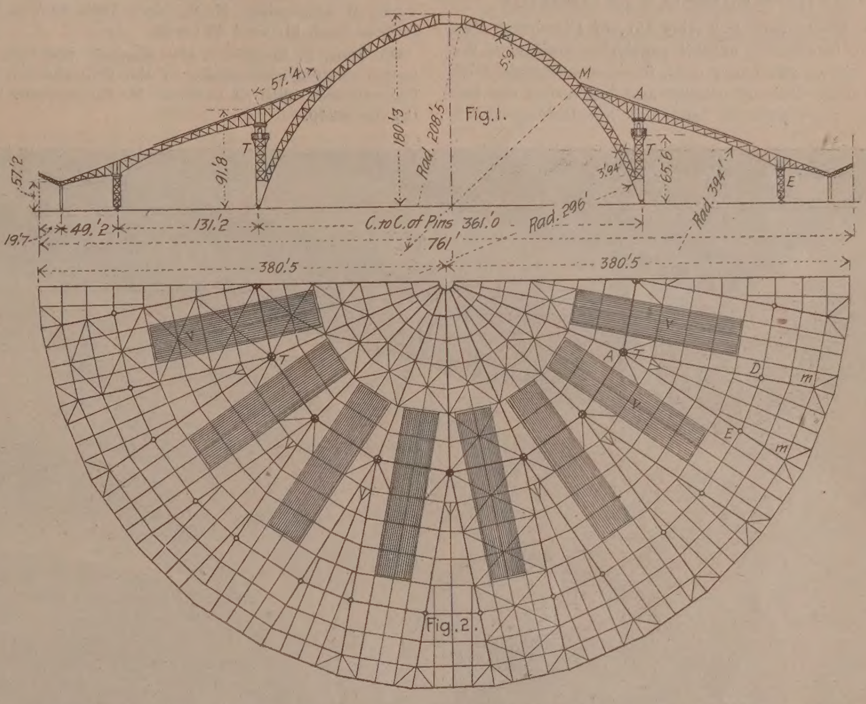
With regard to accuracy, it is found that section paper can be readily printed so that the error is well within 1-5 of 1%, and, therefore, that the accuracy is abundantly sufficient for a very large class of engineering work. On this point it may be well to note that from the peculiar properties of logarithmic scales, an error of a certain amount in the location of a line results in the same proportional error at all parts of the scale. This is readily seen to be due to the fact that in such case the true result is multiplied or divided by a number whose logarithm is the amount of error in question. The peculiar value of this may be seen from an illustration. Suppose, on the scales used, the true distance between 40 and 41 to be 0.1 in., while actually it is in error .01. This would be an error of 10% in itself, but the error resulting from the use of this distance in finding the quotient of 41 by 40 would be simply the ratio whose log., on the base used, is .01, which in such case would be about 1.002. Hence, the error in the result is 1-5 of 1%, while the error in the logarithm was relatively 50 times greater.

It would, therefore, appear, having regard to its wide range of usefulness, its relative accuracy and cheapness, that logarithmic section paper may fairly claim a not unimportant place among the various aids to engineering computations.

IRONWORK OF THE MAIN BUILDING, LYONS' EXHIBITION OF 1894.

We illustrate in the accompanying cut, reproduced from "Le Genie Civil," the general design of the ironwork for the main building now being constructed for the international exhibition to be held at Lyons, France, in 1894. The design and construction of this ironwork present some novelties of especial interest.

The building will be circular in form and will consist of two practically distinct parts, viz., the central dome-like structure and the surrounding gallery. The dome, as it may be called for convenience, is made up of 16 half arches, parabolic in form. The feet of these rest upon a hinged joint and the tops converge to a connection with a circular crownpiece. The arches act entirely independent of each other under the load. The roof trusses of the circular gallery are peculiar in their construction, and in their application of the cantilever principle. From M (Fig. 1), the point where the gallery roof truss connects with the main arch, to A, the point of support over the pier T, the truss is single, but at A it separates into two trusses running from A to m, m (Fig. 2). The weight of the truss between A and D exactly balances the weight of the portion from D to m and one-half of the weight of the section from A to M. Similarly, section AE balances section Em and the remaining half of AM. The arrangement of the horizontal bracing and other roof members are quite clearly shown in the illustration.



GENERAL PLAN OF THE IRONWORK FOR THE MAIN BUILDING OF THE LYONS, FRANCE, EXHIBITION OF 1894.

The total weight of one of the main arches is 30.8 tons and of one of the gallery roof trusses 44 tons. The total weight of the ironwork in the building is 2,497 tons. The area covered by the building is 9.4 acres. The roof will be covered with a metal roofing except where shown shaded in the plan, where it will be glazed.

A NEW FORM OF BOILER MANHOLES.

By A. B. Willits, U. S. N.

It is somewhat strange that since the adoption of the hydraulic flanging machines, wherewith sheets as heavy as 1 in. can be as readily and more quickly flanged than could sheets of a quarter that thickness before the innovation, the old style of flat opening in the sheets for manholes should still continue to be made at all. The advantages of the flanged style are manifest to any one who will look at the matter fairly, and it is only due to the fact that the idea has not been general property that the plain openings with the riveted-on stiffening rings continue to be made anywhere. As long as the construction of Scotch boilers is demanded, and until that happy time shall arrive when the ideal tubular boiler shall have come to stay, so long will their weight and size increase with the advance of pressures, and in proportion will the care in construction be necessarily increased.

Every boilermaker knows that with these high pressures one of the most difficult things he has to contend with is the obtaining of a good fitting manhole plate. These nearly always leak about the joint when put to the test, and even if they are finally set up to perfect tightness at the time, they will often prove a fruitful source of bother and trouble whenever it is necessary to remove them for examination of the interior of the boiler and the joints have to be renewed.

A glance at the illustration (Fig. 1) will show that the reason for this trouble is usually the lack of an accurately faced surface for the manhole cover to seat on. As this surface is the boiler shell itself, it is easy to see that it cannot in all cases be faced at all, and never with that degree of perfection and ease that the turned-in lip of the flanged plate can. This latter plan is shown in Fig. 2, and after the sheet is flanged, an act requiring but a short space of time and being accomplished with one stroke of the piston of the flanger (with accurately cast formers and dies), the plate is placed under a small boring mill and the lip faced off perfectly, in very short order. This makes such a strong and stiff bearing face that the plate is set

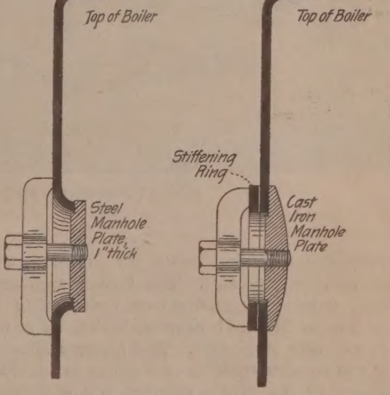


Fig. 2. New Style with Flanged Opening. Fig. 1. Old Style with Stiffening Ring.

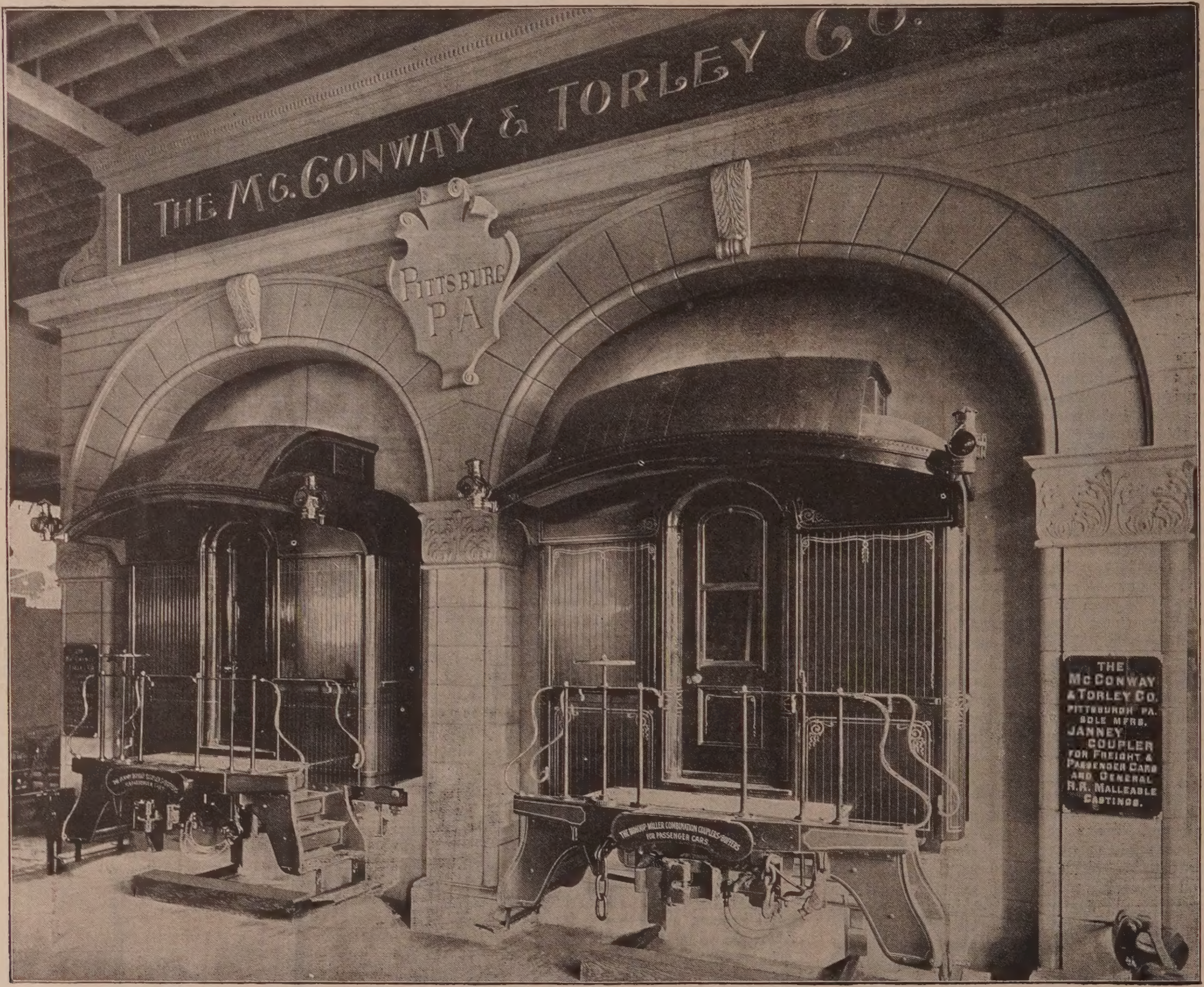
MANHOLE AND COVER FOR MARINE BOILERS.

up perfectly tight with a small single-hand wrench. The form commends itself to practical men for other reasons, and should be universally adopted where the facilities for making it are at hand. Accompanying this change have come modifications in the cover plate. The old and heavy cast iron covers are giving way to the lighter and safer wrought iron or steel ones.

THE McCONWAY & TORLEY CO.'S EXHIBIT AT THE COLUMBIAN EXPOSITION.

The McConway & Torley Co., of Pittsburg, Pa., has an interesting exhibit consisting mainly of the ends of two passenger cars, fitted respectively with the Janney-Buhoup coupler and buffer (on the left of the accompanying cut) and the Buhoup-Miller combination coupler and buffer for passenger cars (on the right of the cut). The former appliances are being extensively adopted on roads using the Janney type of M. C. B. coupler, which, as is well known, are very numerous. The latter appliances are for use on cars running over roads using either the Janney or the Miller coupler, and enable the change in coupling to be made in a very few minutes. This combination has already been applied to between 3,000 and 4,000 passenger cars in use on all parts of the railway system of the United States.

As will be seen by the cut, the car ends are built against a partition and are completely equipped with steps, lamps, hand rails, brake wheels, safety chains, air-brake and steam heating hose, and it is amusing to note that quite a number of visitors apply for permission to go through the cars. The exhibit is, of course, visited by a large number of railway men and attracts considerable attention. In addition to this passenger equipment the Janney freight coupler is also on exhibition.


THE McCONWAY & TORLEY CO.
PITTSBURG P.A.
THE McCONWAY & TORLEY CO. PITTSBURGH PA. SOLE MFRS. JANNEY COUPLER FOR FREIGHT & PASSENGER CARS AND GENERAL R.R. MALLEABLE CASTINGS.
THE BUHOUP-MILLER COMBINATION COUPLERS-BUFFERS FOR PASSENGER CARS

JANNEY-BUHOUP AND BUHOUP-MILLER COMBINATION COUPLERS AND BUFFERS FOR PASSENGER CARS.
IN TRANSPORTATION BUILDING, WORLD'S FAIR.

PERSONALS.

Mr. John Robinson, Master Mechanic of the Lake Shore & Michigan Southern shops at Buffalo, died on Sept. 19.

Mr. Alonzo H. De Graff, Superintendent of the waterworks at Amsterdam, N. Y., since 1881, died at Amsterdam, Sept. 21, aged 46 years.

Mr. Thos. C. Ruggles, a civil engineer who took part in the original construction of the Erie and the Harlem railroads, died at Yonkers, N. Y., on Sept. 22 at the age of 79.

Mr. Fred. W. Abbot, Assoc. M. Am. Soc. C. E., Assoc. M. Inst. C. E., has resigned his position as Chief Engineer and Assistant General Manager of the tunnel for the drainage of the City of Mexico, to engage in contracting business in St. Louis.

Mr. Austin F. Park, a graduate of the Rensselaer Polytechnic Institute in the class of 1841, died at Troy, Sept. 22. Mr. Park was in the employ of W. & L. E. Gurley from 1845 to 1854, and has since that time had a wide and successful practice as a patent attorney.

Mr. Arthur G. Wells has been appointed Assistant to First Vice-President D. B. Robinson, of the Atchison, Topeka & Santa Fe R. R., in place of the late Henry C. Ives. Mr. Wells resigned his position as Superintendent of the St. Louis division of the Big Four system last March.

Mr. W. J. McKee, Superintendent of the Newport News & Mississippi Valley Co., has resigned to accept a position on the Missouri Pacific, with headquarters at Little Rock, Ark.

Mr. Sandford Fleming, M. Am. Soc. C. E., sailed for Australia on Sept. 16 to investigate the feasibility of a submarine cable line from Australia to Vancouver, via the Sandwich Islands.

Mr. Lewis Williams, General Superintendent of the New York, Chicago & St. Louis, has resigned and will be succeeded by Mr. Albert W. Johnston, Superintendent of the Eastern division.

Mr. R. W. Bryan, who has been Superintendent of the Breckenridge division of the Great Northern Ry., has been promoted to be Assistant Superintendent of the whole system. Mr. O. O. Winter, Superintendent of the Minneapolis Terminal Ry., will take charge of the Breckenridge division.

Mr. John D. Fouquet, M. Am. Soc. C. E., and architect for the New York Central & Hudson River R. R. Co. for the past ten years, will withdraw from the service of that company after Oct. 1, and open an office for general practice at 35 Broadway, New York city. He will make a specialty of railway structures.

Mr. B. J. Arnold, for several years Consulting Engineer at Chicago for the General Electric Co., has resigned his position from Oct. 1. Mr. Arnold has opened an office in The Rookery, Chicago, and will make a specialty of surface and elevated railway work, in which he has had much experience. He was with the E. P. Allis Co., of Milwaukee, and later was designing engineer with the Iowa Iron Works, of Dubuque, and was mechanical engineer of and designed the locomotives for the Chicago, St. Paul & Kansas City Ry. He resigned this position to take a postgraduate course in electrical engineering at Cornell University, and was then made engineer and manager of the St. Louis office of the Thomson-Houston Co., and after serving in this position for 1½ years he was appointed to the office he has just resigned. Mr. Arnold's work on the Intramural power station, at the World's Fair, and the power house of the Little Rock, Ark., railway have been described in Engineering News within the last year.

Mr. Ralph Modjeski, Assoc. M. Am. Soc. C. E., has formed a partnership with Mr. Ernest Nickerson, who has been connected for some years with the Atchison, Topeka & Santa Fe R. R., and the firm will make a specialty of the designing and building of railway bridges, viaducts, trestles and metallic structures in general. Their offices will be in the Monadnock Block, Chicago. Mr. Modjeski has been in practice as a consulting engineer for a year past, and was a member of the staff of Mr. Geo. S. Morison, M. Am. Soc. C. E., for several years.

NEW PUBLICATIONS.

STATE BOARD OF HEALTH OF INDIANA; Report for the year ending Oct. 31, 1893. C. N. Metcalf, Indianapolis, Secretary. 8vo; pp. 311; tables.

Like nearly all the states of the Union Indiana is doing little or nothing through its health board of engineering interest. In view of the good work being done by the Massachusetts, Connecticut and New York boards, especially the former, it seems a pity that the other states do not take up some of the many phases of stream pollution and sewage and water purification. The Indiana report contains a general summary of the legislative action of many of the states to prevent stream pollution, the summary being included in its account of the National Conference of Boards of Health at Lansing, Mich., in 1892.

MUNICIPAL OWNERSHIP; ITS FALLACY: With Legal and Editorial Opinions, Tables and Cost of Lights as Furnished by Private Companies and Municipal Plants. By M. J. Francisco, Rutland, Vt. 8vo; pp. 104.

Every year or two something may be expected from Mr. Francisco against the public ownership of natural monopolies, and especially against the municipal ownership of electric lighting plants. This last pamphlet is perhaps superior to the others in that it presents detailed figures regarding the cost of electric street lighting in about 75 cities which own their plants. Only a few detailed figures are presented regarding the cost of lights furnished by private companies, and in comparing the cost of street lighting under private and public ownership no account is taken of the revenues from commercial lighting, which, to say the least, is more common in the case of private than of public lighting plants. It is only fair to state that much of what has been written in favor of municipal ownership has been extremely unfair in that not all of the elements of cost have been considered.

PILES AND PILE DRIVING. Being a Reprint of the Articles which Have Appeared in Engineering News on Pile Driving and the Safe Load of Piles, and of the Pamphlet on "Bearing Piles," by Rudolph Hering, M. Am. Soc. C. E. Edited by A. M. Wellington, M. Am. Soc. C. E., M. Inst. C. E. New York: Engineering News Publishing Co. 12mo; paper; illustrated; pp. 150; 50 cts.

This being one of our own publications, prepared by a member of the editorial staff of this journal, we make no extended review of the work. The contents and general scope of the book are quite fully given in the following extract from the preface:

> The following work contains a reprint of some of the more important articles on the subject of "Bearing Piles" which have appeared from time to time in Engineering News, including especially those in which what has since become known as the "Engineering News Formula" for the safe load of piles was announced, explained and defended. It also includes a reprint of a valuable pamphlet on "Bearing Piles," by Rudolph Hering, M. Am. Soc. C. E., which was published some years ago by the Engineering News Publishing Co., but long since went out of print; and a full abstract of a paper by Mr. Foster Crowell before the American Society of Civil Engineers on "Uniform Practice in Pile Driving," with the dscussions thereon.
>
> It is believed that this little volume contains about all that can be required in any case for solving the most serious problem connected with pile-driving, What load can be placed on given piles with safety? But if it be desired to find fuller information as to specific records, the back files of Engineering News, of Transactions of the American Society of Civil Engineers and of the Proceedings of the Institution of Civil Engineers should be consulted, as they all contain further information of value; though the more important information to be had from all these sources is given in substance in this volume.

SOCIETY PROCEEDINGS.

WESTERN RAILWAY CLUB.—The annual dinner was held at the Grand Pacific Hotel on Sept. 19, and about 86 members and guests were present. Addresses were made by Messrs. W. H. Lewis, the retiring president, and Mr. Wm. Forsyth, the newly elected president. A number of foreign railway officers in attendance at the Columbian Exposition were present.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Sept. 20 a paper, by James D. Schuyler, M. Am. Soc. C. E., on "The Water-Works of Denver, Colo.," was read in abstract by the Secretary. The greater part of the contents of this paper has already been given in our issues of Sept. 22, 29, 1888, April 28, 1892, and Aug. 31, 1893, and such further details as are of interest will be given in a future issue, together with parts of the discussion which is not yet available.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on Sept. 12 Mr. Thos. D. West read a paper entitled "Engineering; the Establishment of Competitive Manufacturing Enterprises," which was discussed by Messrs. Ludwig Herman, John Walker and Jos. L. Gobeille. Prof. C. H. Benjamin read a paper entitled "Experiments on the Elastic Strength of Steel Hoops," which was discussed by Messrs. Osborn, Searles, Gifford, Langley, Herman, Walker and West.

Frank C. Osborn, Secretary.

NEW YORK RAILROAD CLUB.—At the meeting on Sept. 21 various topical questions were discussed. On the first, whether brakeshoes should be applied to every wheel of a train, the general opinion expressed was that this was the inevitable tendency of good practice. On the question whether jacks and other heavy tools should be carried on locomotives, the trend of the discussion was that on roads of heavy traffic it was better to keep at stations such tools as are usually carried on locomotives, and carry in the baggage car or the caboose such tools as it was deemed best to have on the trains. On branch roads or roads with stations few and far apart, a full equipment of tools should be carried on the locomotive. The last topic was whether it was good practice for a builder to send out a locomotive with its eccentrics held only by set screws. There was little dissent from the opinion that it was decidedly not good practice.

ENGINEERING ASSOCIATION OF THE SOUTH.—At the meeting in Nashville, Tenn., Sept. 14, Mr. W. G. Williamson discussed the relations between the city Council, the Board of Public Works and the City Engineer. He concluded that in small cities the existence of both the Council and the Board causes needless complications, though in large cities the great amount of public works makes the board more efficient than a committee of the Council; that the engineer should be appointed by the Board, but should not be embarrassed by their appointing any of his assistants; that orders to the engineer should proceed from but one authority, and if these orders are contrary to the judgment of the engineer, he should be allowed to place his objections on record; and that it is not good economy to bind an engineer to let work to the lowest bidder.

Mr. Walter G. Kirkpatrick read a paper describing a "System of Triangulation for River Surveying." Mr. J. S. Walker discussed the roof trusses of the World's Fair buildings. Mr. Hunter McDonald described the methods used and progress made in sinking caissons 40 ft. under water for foundations of the bridge now under construction over the Tennessee River, for the Nashville, Chattanooga & St. Louis Ry.

Walter G. Kirkpatrick, Secretary.

WESTERN SOCIETY OF ENGINEERS.—The reception and entertainment of the party of distinguished French engineers which arrived in Chicago on Sept. 10 was carried out in a manner which reflects much credit on the Society. The reception committee appointed at the meeting on Sept. 5, with Mr. Octave Chanute as chairman, met the visitors upon their arrival, and escorted them to the Auditorium Hotel. On the morning of the following day, the party assembled at the Engineering Headquarters, and were formally welcomed by Mayor Harrison. They were then taken in the Columbian coaches to the Washington Park Club, where breakfast was served. Following this came a visit to the Columbian Exposition and a reception at the Administration Building, by Director-General Davis, and other prominent officers.

On Tuesday the trip to the grounds was made by the whaleback steamer, and the guests inspected the moving sidewalk and the Intramural Ry., and were received by the French Commissioners. On Wednesday the stockyards and the Riverside shops of the Illinois Central were visited. On Thursday a trip down the drainage canal was planned, but was attended by only a few of the foreign guests through a mistake in the delivery of the invitations. The remaining four days of the visitors' stay were devoted to general sightseeing. A reception was held in their honor by the Associated Engineering Societies on Friday evening, Sept. 15, and they were banqueted at the Union League Club on the following Monday evening.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK.—The eleventh annual meeting was held at Rochester, N. Y., Sept. 19. A letter of regret was read from the President, C. Densmore Wyman, who is now connected with the Electric Launch & Navigation Co. at the World's Fair. In his absence, Vice-President D. B. Hasbrouck, of the Houston, West St. & Pavonia Ferry Co., took the chair and made a brief address. The report of the Executive Committee showed that five companies had joined the Association during the year, and three had been consolidated with member companies, making the present membership 28. The rapid development of electric traction in Brooklyn was noted. The committee congratulated the members that during the last session of the legislature not a single bill intended to injure street railway interests had become a law.

The business outlook was touched upon as follows:

> The street railway business is a delicate financial meter that indicates with certainty the financial condition of a people. In proportion to the prosperity of the people is our business successful; and the converse is equally true. Judged by this infallible test, therefore, we are assured that the business depression of the country is passing away.

In closing the report a fitting tribute was paid to the memory of the late John Stephenson.

Mr. Geo. W. McNulty, from whom a paper on "Recent Improvements in Cable Traction" had been announced, sent a letter explaining that the innovations which he has introduced and proposes to introduce on the Broadway Cable Ry. had not yet been sufficiently tested to warrant their description. He promised, however, to prepare a paper for next year's meeting. A paper by Mr. T. J. McTighe on "The Return Circuit for Electric Railways" was read and discussed. The substance of the paper is reprinted in another column. This concluded the technical work of the convention, and after the election of officers the convention adjourned. The election resulted as follows: President, D. B. Hasbrouck, New York city; First Vice-President, G. Tracy Rogers, Binghamton; Second Vice-President, James H. Moffitt, Syracuse; Secretary and Treasurer, W. J. Richardson, Brooklyn. Executive Committee; John N. Beckley, Rochester; Daniel F. Lewis, Brooklyn; Charles Cleminshaw, Troy.

COMING TECHNICAL MEETINGS.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Oct. 2. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Oct. 3. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Oct. 4. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
Oct. 4. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Oct. 4. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF MINNEAPOLIS.
Oct. 5. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Oct. 6. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Oct. 6. Secy., O. Von Geldern, 719 Market St., San Francisco
ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 7. Secy., L. F. Rondinella, 1122 Girard St.
DENVER SOCIETY OF CIVIL ENGINEERS.
Oct. 9. Secy., F. E. King, Jacobson Block.
ENGINEERS' CLUB OF KANSAS CITY.
Oct. 9. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Oct. 9. Secy., M F. Schinke, City Hall.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Oct. 10. Secy., F. C. Osborn, Case Library Bldg.
NORTHWEST RAILROAD CLUB.
Oct. 10. Secy., W. D. Crosman. Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Oct. 10. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
INTERNATIONAL IRRIGATION CONGRESS.
Oct. 10–14. Los Angeles, Cal. Arthur L. Thomas, Salt Lake City, Utah, Chairman National Executive Committee.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Oct. 11. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Oct. 11. Secy. F. M. Curtis, O. C. R. R., Boston.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Oct. 12. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERING ASSOCIATION OF THE SOUTH.
Oct. 12. Secy., W. G. Kirkpatrick, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Oct. 12. Secy., F. W. Mowbray, Norton Building.
AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS.
Oct. 12. Chicago, Ill. Secy., C. A. Hammond, 350 Atlantic Ave., Boston, Mass.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Oct. 13. Secy., D. W. Meeker, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Oct. 14. Secy., G. O. Foss, Helena.
WESTERN RAILWAY CLUB.
Oct. 17. Secy., Clement F. Street, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
Oct. 17. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Oct. 17. Secy., R. H. Clark, Pittsburg.
INTERNATIONAL ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17–19. Annual Convention at Continental Hotel, Philadelphia. Secy., S. F. Patterson, Concord, N. H.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Oct. 18. Secy., S. E. Tinkham, 36 Broomfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 18. Secy., L. V. Carmalt, Roanoke, Va.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct 18–20. Annual Convention at Milwaukee. Secy., Wm. J. Richardson, Brooklyn, N. Y.
NEW YORK RAILROAD CLUB.
Oct. 19. Secy., John A. Hill, Temple Court, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Oct. 19. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Oct. 19. Secy., Allen Strale, 100 Washington St.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Oct. 20. 201 Washington Building.
SWEDISH ENGINEERS' CLUB.
Oct. 21. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Secy., S. A. Charpiot, Macon, Ga.
CENTRAL RAILWAY CLUB.
Nov. 22. Secy., S. W. Spear, Buffalo, N. Y.

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The headquarters of Engineering News on the grounds of the World's Columbian Exposition are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U N, Posts 10 to 11 (office No. 9), of the Transportation Building Annex, at the west end of the Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:25 a. m., of each week day, and from 10:35 to 11 a. m. at the second-named office, in the Transportation Building; as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

The Engineering headquarters, at Chicago, are at No. 10 Van Buren St., directly opposite the viaduct leading to the Illinois Central R. R. World's Fair trains, and to the steamboat pier, and but a stone's throw from it. The rooms are large and comfortable, and include reading, writing, smoking and other apartments. The rooms are to be kept open during the Fair by subscriptions of engineers, and all American and foreign engineers visiting Chicago are invited to register and make free use of the rooms during their stay, and to have their mail addressed there. An informal reception is held at these rooms every Monday evening from 8 to 10 p. m.

◆

Our knowledge of sewage purification is increasing rapidly, thanks to the experimental work of the Massachusetts State Board of Health and the practical results being obtained by the 30 odd American cities and towns whose sewage purification plants have been described in these columns within the past year or so. Most of these plants have been built in the last six or seven years, and it is now nearly six years since the Lawrence experiments were begun. The latest results at Lawrence are detailed elsewhere in this issue, and from them and the previous results of the Massachusetts work we may conclude that: (1) For a high grade of purification, including the removal of both organic matter and bacteria, intermittent filtration through properly underdrained filter beds is the most practicable method yet devised to meet the wants of American communities. (2) That the best filtering material for such beds is sand of uniform size. (3) That the proper rate of filtration and frequency of application of the sewage vary greatly with the size of the sand particles, but may be determined by a mechanical analysis of the sand, the character of the sewage to be treated and other ascertainable conditions; fine sands and coarse sands and gravels are to be avoided, except in special cases. (4) Except in the most severe climates intermittent filtration may be successfully practiced in winter without special precautions against frost and snow. These are some of the practical conclusions which may be drawn from the experiments. Others are given and some of these are elaborated elsewhere in this issue, notably the fact that intermittent filtration is not a straining, but rather a nitrification process, depending upon the presence of air and bacteria in the filter.

The Lawrence work has been confined to filtration on the intermittent and continuous plans and to chemical precipitation. Broad irrigation has not been taken up, the limited area at the experiment station prohibiting it, even supposing there had been a desire to try this method, regarding which point we are not informed. Continuous filtration has been shown to be impracticable, and chemical precipitation does not give so high a degree of purification as intermittent filtration.

◆

To avoid the dangers arising from the use of sewage-polluted water supplies drawn from the Merrimac River, the cities of Lawrence and Lowell have adopted two different methods, the comparative results from which will be watched with interest: Lawrence is purifying the river water and Lowell is obtaining an independent supply from driven wells. The Lawrence filter beds (see Eng. News, Aug. 3, 1893) were put in operation on Sept. 20, 1893, and the Lowell driven well plant a few days earlier. Lawrence has expended about $60,000 in constructing filter beds with a capacity, as designed, of 5,000,000 gallons per day, the water from which flows to the old pump well, while Lowell has spent about $25,000 for wells of a guaranteed capacity of 5,000,000 gallons and in addition some $75,000 for a pumping station and force main.

The quantity of water that may be drawn from the Merrimac River at Lawrence is practically unlimited, and the filter beds may be increased in area as becomes necessary. If it turns out that the driven well supply at Lowell may also be increased indefinitely, within reasonable limits, by putting down more wells, the relative merits of the two schemes will depend upon: (1) Which city will secure its supply of water at the least cost per 1,000,000 gallons, including interest charges on cost of construction, and making proper allowances for unavoidable natural conditions; and (2) more important by far than mere expense, which city will obtain water best suited to the various uses for which it is designed, the freedom of the supply from contamination ranking first in importance.

A fair amount of preliminary testing was done to determine both the quantity and quality of the Lowell well supply, we believe, before the construction of the plant was started, and with satisfactory results. The Merrimac River water at Lawrence has been found capable of a high degree of purification in the small filter tanks used at the Experiment Station. In both cases the experiments must now be tested by work on a large scale, and at Lawrence the cost of operating the beds must be determined. This cost will depend almost wholly upon the expense of scraping the clogged upper layer of sand from the filters and replacing it, after a certain depth has been removed, either with new sand or the old sand after it has been cleaned in some way. During high water the river carries a large amount of silt, which will clog the beds rapidly, necessitating frequent removal of the surface sand.

Whatever the comparative results and comparative expense may be in the two cities, a greatly improved water supply may be confidently expected in each case, followed by a marked reduction in the typhoid fever death rate, which for years has been very high in both cities.

◆

We give space in this issue to a recent paper on the return circuit of electric railways, a subject which is attracting a large amount of attention, not only from engineers engaged in electric railway work, but from those in charge of gas and water pipes and other underground street furniture which has suffered injury from electric railway ground currents.

It is interesting to trace the changes of practice in the treatment of the return circuit which have occurred in the few years since the single-trolley system of electric railways came into use. The first roads were more or less experimental; cars were few, motors were of limited power, and the total quantity of current flowing to earth was so small that no one thought of paying any attention to the return circuit. It was expected to leak into the ground from the track rails and take care of itself.

But it was very soon found that the contact of the rails with the earth was not sufficient to permit the passage of the current to the earth without a material loss, especially in roads on a dry, sandy soil, and in dry weather. Steps were, therefore, taken to more perfectly ground the current. Iron plates or old rails were buried at a depth sufficient to reach moist earth at various points on the line, and the rails were connected together by wire bonds to facilitate the passage of the current through them, so that they would serve to some extent as return coductors and also to facilitate the passage of the current to the ground.

Up to a recent period no attention has been paid to any other method of providing for the return current; and it was not until the great current of electricity passing through the ground was found to be making havoc with underground pipes along roads of heavy traffic that attention was called to the importance of obtaining a return circuit of less resistance. Several roads of heavy traffic have strung one or more heavy copper wires along the line of their road, either overhead or underground, to decrease the amount of current passing through the earth, and consequently the loss due to the resistance and the corrosion of pipes, etc.

◆

The writer whose paper is published in another column attacks this practice of using a supplementary wire or wires for the ground return. He declares, what is undoubtedly true, that the track rails themselves have greater conducting power than the largest supplementary return wires ever used, and holds that by properly bonding the rails they can be utilized to much better advantage than the frequently used supplementary wire.

The writer's position is certainly correct, provided only that it is practically possible to make a substantial, reliable and durable bond between adjacent rail ends. The great trouble with the rail bonds which have been generally used appears to be that they were designed with little reference to the current which they had to carry. They have been expected merely to aid the current in its path to the ground, and have been so overloaded by heavy currents that they have in many cases proved unsatisfactory. Even with the best bonds of ample size, however, the current must cross at least two contacts at each rail end, or with 30-ft. rails it must cross 3,520 contacts per mile. If any one of these contacts fails, the rail return is useless: the chances of failure can be materially lessened, however, by connecting all four rails of a double-track line by frequent cross bonds, so that in case one contact is defective the current can pass by the other rails of the line.

But, granting that rails can be so bonded that they will make efficient conductors while the track is new, it is not yet certain that these bonds can be made permanently reliable. It is essential, of course, that the contact should be between clean unoxidized surfaces; but will not moisture gradually creep in between the contact surfaces and cause oxidation? And when oxidation once begins and the resistance to the current is increased by ever so little, this very increase of resistance tends to increase the corrosion at this point.

We are far from saying that it is impossible to make a permanently durable and practically successful electrical bond between the ends of street rails. Very likely it can be done; but until some extended experience proves its possibility, the engineers who put down a supplementary wire to take care of the return circuit are not so foolish as might at first appear.

It is of interest to notice in this conection that the continuous rail which the Johnson Co., of Johnstown, Pa., is now making on the West End Ry., in Boston, by electrically welding together adjacent rail ends in the track will, if it proves

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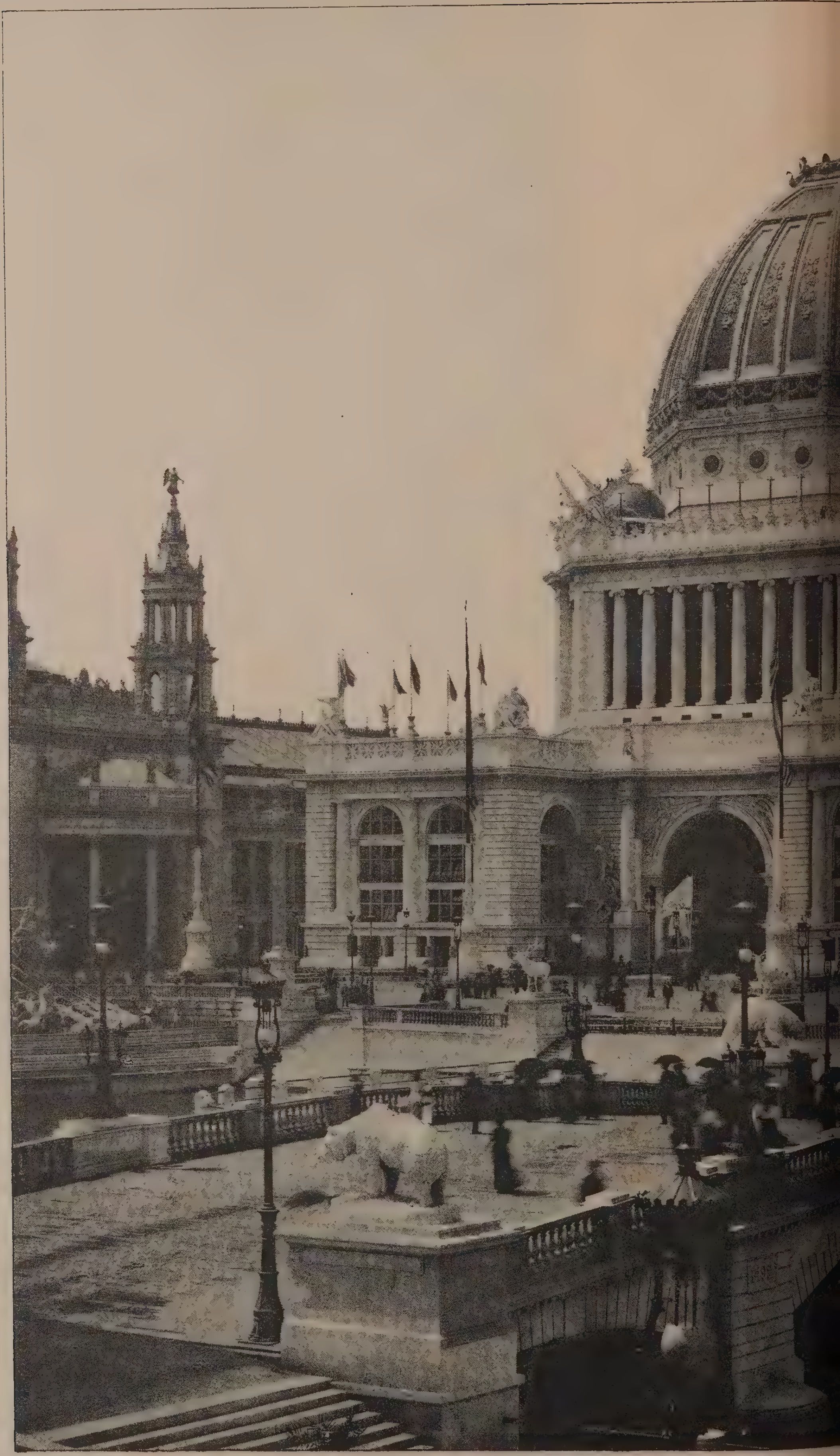

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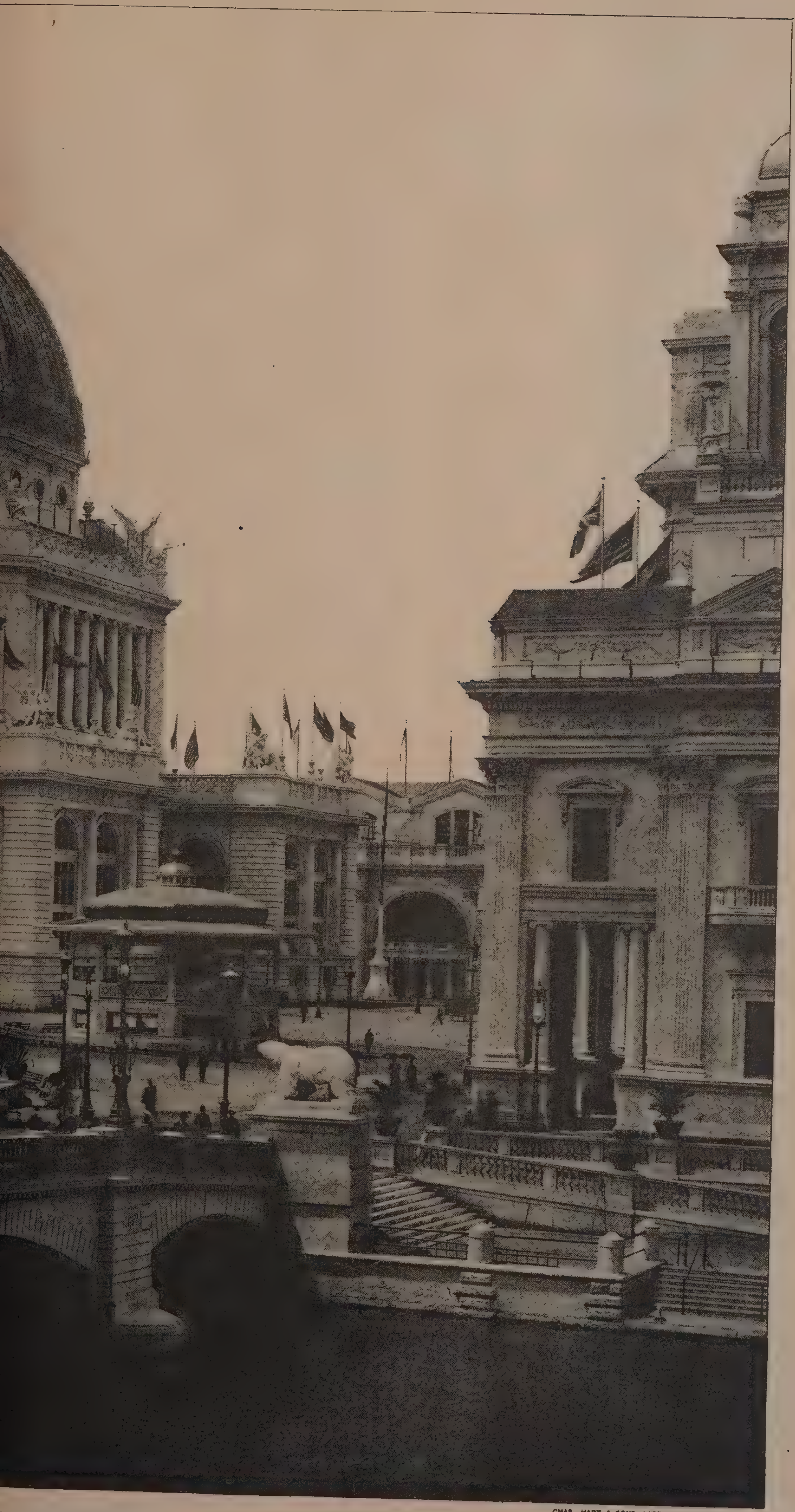

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practically successful, not only solve the troublesome joint problem, but will furnish an ideal path for the return current, and save the expense of making and maintaining rail bonds save at the few points where adjacent sections meet.

It is a wise railway officer who takes advantage of serious train accidents to impress upon his subordinates the responsibilities which are laid upon them and the need for constant care and watchfulness. For example, the superintendent of one of the trunk line roads, which uses the block system with permissive blocking, issued a circular letter to all his conductors immediately after the Long Island accident, calling their attention to the circumstances of that disaster and enjoining upon them strict observance of the flagging rules, and the greatest care in protecting the rear of their trains. The serious disasters of the past few weeks have been object lessons which should be brought home to employees in every way possible. The newspaper reports of these accidents are often wholly unreliable, and superintendents should see that correct statements, showing just the breach of the rules or the lack of care which led to the fatal result, are placed in the hands of every employee who is in a position to profit by it.

Educational work of this sort is especially needed among the enginemen on roads which have a small portion only of their length operated under the block system. The man who works year in and year out in obedience to fixed signals acquires the habit of careful observation and implicit obedience to them which is lacking in the man who has only a few miles of his run under their protection. Such accidents as the recent one near New Orleans (where the runner of a freight train went at full speed past both distant signal and home signal set at danger and plunged with his locomotive into an open draw) ought to be brought to the attention of enginemen.

The education in the necessity of implicit obedience which they will get by talking over such occurrences among themselves will do more to make them careful and reliable runners than can be done by the most rigid system of rules and the severest punishment of disobedience.

As far as rapid transit in New York is concerned, the public has to content itself with rumors just now, though of these the crop is bounteous. Within the last 10 days we hear that "five responsible capitalists," with Mr. Austin Corbin at the head, have made a proposition to build the underground road on the plans of the commission; then comes a rumor that the firm of Ryan & McDonald, the builders of the Belt Line tunnel, in Baltimore, were willing to go to work at once, with Mr. W. C. Whitney as an alleged backer; and finally we hear that the Manhattan company will, before long, reopen negotiations. The Rapid Transit Commission denies that any foundation exists for the first two rumors and the only ground for the last seems to be that the Manhattan company has not by resolution closed all negotiations with the Commission. The further rumor that the Manhattan will couple its next proposition with a threat to end the life of the Rapid Transit Commission by legislative action must be taken for what it is worth, and that seems to be little enough.

The latest of all schemes filed with the Commission is that of Mr. Herman Rausch, who proposes to build at Mott Haven a union depot to accommodate all lines entering the city, and then to utilize the New York Central tunnel and tracks to Forty-second St. From this latter point he would continue downtown with a four-track tunnel, by way of Fourth Ave., Astor and Lafayette places and Elm St., to Pearl, thence with two tracks loop around the City Hall and back to Pearl St. This plan has the decided advantage of substituting Elm and other streets for the more difficult Broadway and accords in that respect with suggestions made long ago in this journal. Elm St. is to be widened anyhow, and it is even yet possible to widen it sufficiently to make much of the roadway in open cut with bridges at the street crossings. A line in this street of old and low houses with a minimum of underground pipes and sewers should eliminate much of the danger and risks of tunneling to be met with in Broadway. And any wise contractor will include these risks in his bid and make the city pay for them. It is a question just upon what terms and conditions the city could engage the New York Central Ry. Co. to enter into the scheme proposed by Mr. Rausch, and it is possible that there would be little gain over a deal with the Manhattan company in this respect. But even if the Elm St. route were made to connect with the route of the Rapid Transit Commission above Union Square, the lower and more dangerous part of the line on Broadway would be abandoned and the whole underground scheme would be made more inviting to capital, as coupled with less risk, and should thus be cheaper to the city. As far as convenience is concerned, Elm St. is but one block away from Broadway at the City Hall and only two short blocks away at the end of the proposed continuation.

THE CHESTER BRIDGE DISASTER FINDING.

The findings of the Board of Railroad Commissioners on this terrible disaster have at last been rendered and are given substantially in full in another column. The more important parts of the testimony we gave two weeks ago. The finding is, on the whole, a just finding, and yet in its practical effect we fear it will prove to be an unjust one, for, in popular acceptation at least, it places the onus of responsibility upon an ignorant foreman, touching comparatively lightly upon the long chain of more responsible and more guilty superiors above him, who are yet shown by the testimony taken at the investigation to deserve far graver censure, as having risked many times over just such an "accident" as actually occurred at last, though "the grace of God and force of habit" have prevented their careless ways from having heretofore their natural results. To our thinking, more just blame rests upon half a dozen of them at least than upon the unfortunate foreman Belville, who has been hailed by the New England press generally as the main culprit in consequence of the commission's finding, the first sentence of which relating to apportionment of the blame was as follows:

> The immediate responsibility for the disaster rests upon Daniel Belville, the foreman, who had the charge and direction of the work, and who, on this day, recklessly allowed the work to be done by improper methods, and the bridge to be left in an utterly unsafe condition, and heedlessly neglected to warn the coming train.

Now, who was Daniel Belville? By his own testimony he is a boiler-maker by trade and 36 years old. At 16 he began work as a mechanic in Rome, N. Y.; at 19 he went to Sandusky; at 20 he went to the Leighton Bridge Co. and "worked at riveting off and on" until 27, "sometimes" as foreman. Then he went to firing a locomotive for a year, then back to riveting, then back to firing again, then "back to bridging." Then, at some unstated time he drifted off to run a stationary engine at North Adams, Mass., working at these several occupations for six years, until he was 33. Then, three years ago, he drifted into Mr. Hawkins' employ as a riveter, and at some unstated time was made foreman of a gang of 13 riveters under a Mr. Reed, who, this season, had finished strengthening 11 bridges, and was in charge of 17 others in the vicinity strengthened and to be strengthened, all beyond question in the same general manner as this one was.

The above record shows that Belville was without any erecting or other shop experience to give him the least idea of the nature of bridge strains or of the conditions of strength and weakness. His offense, as explained by the commissioners, was that, as new plates were laid against the old, of the truss to be strengthened, the old rivets should have been removed gradually, new rivets or bolts being driven in their places to secure the old and the new parts; but by Belville's direction the rivets were removed for a space fully 25 ft. in length, and the fastenings of the cover plates to the chord and to each other were merely nominal for this distance. At this juncture of the work Belville called the workmen from their labor on the bridge to aid in unloading a carload of iron which arrived from the works, and, this accomplished, he allowed the men to go to dinner without returning to their work on the bridge.

Now Reed, who was Belville's immediate superior, was an outside superintendent for Mr. Hawkins, reporting directly to him, but also subordinate to General Manager Moulton and General Superintendent Mulligan, of Mr. Hawkins' staff. He had been in his present position three or four years, and in the same service 15 years, and showed a good record as foreman, though an absolute lack of any knowledge as to the theory of bridge strains. But his testimony showed that he had been at the bridge only 15 minutes on the day before, had given no instructions and done nothing except to give notice of the arrival of the very carload of iron which was the indirect cause of the disaster. His testimony also showed explicitly that he was not following the details of the work; but had merely told Belville "at the first start-off how to do the work," which Belville declares was to put bolts or drift pins in every third or fourth hole, and which, he declares, he did, though Reed declares his instructions were to bolt or drift-pin every other hole. This, be it noted, was a degree of precaution taken only when the bridge was to be left standing for some time, for trains to pass over while the men were away. Otherwise, they "took advantage of trains and put the plates on between their running," according to Reed's testimony, but he admits that he gave no timetable to Belville to show when trains were due, and in view of what Belville actually did, who can believe that even this amount of precaution was actually taken either on this bridge or on the 17 others in question?

Now, let us pass to the testimony of Reed's only real superior on this work of strengthening, Mr. R. F. Hawkins. Mr. Hawkins is well known as an old bridge builder, who has built great numbers of highway bridges in New England, but very few out of it, and who has enjoyed a practical monopoly of the bridge-building work of the Boston & Albany and several other New England roads for many years. He testifies that he was doing work under a kind of running verbal contract which was revised as to prices from time to time, but was on the pound and day's work basis. "It was not specified as to supervision. He understood that he was to furnish the best quality of work in the best manner and that was all there was of it." As to the particular work in charge of Mr. Reed: "He was in charge of this and other bridges. Witness gave no attention to this bridge. No one besides Mr. Reed gave ANY supervisory care to the work. Witness told him to employ such men as were necessary to do the work. Reed had authority to hire men and arrange for the supervision of the work. Witness had not been to the wreck and knew nothing specially about it."

Such was the supervision exercised by Hawkins over Reed, by Reed over Belville and by Belville over his men. Bearing in mind the fact which we shall shortly review, that "in a word, there was no supervision of the work whatever on the part of the railway company," where does the greatest guilt lie as between the parties not in the employ of the railway? Let the reader make up his own opinion and then read clauses 4 to 8, inclusive, in the commission's findings, in another column. It will be found that they lay all the onus of blame on the unlucky Belville, and go out of their way to give Mr. Hawkins a certificate of character which cannot but be generally interpreted as acquitting him of all blame, though it does not in terms say so. It does not either say or imply the contrary, and yet—what more damning implication of unfitness for such an unusual and extraordinary trust as was placed by this company in its sole contractor could possibly exist?

The commission only say that it was not "wise nor proper" for the company to vest such unusual authority in an outsider, and they say that only after they have just said in effect that the "confidence was well grounded" which led the company to place such absolute trust in Mr. Hawkins. Was it? Did the testimony justify the commission in saying it was? We fail to see it so, and the bridge engineers of the country with hardly an exception will support us in that view.

Coming now to the company's share of responsibility the commission rather go out of their way to state that the bridge had always been regarded by "the experts of the company" as a good and safe bridge. Who were the "experts of the company"? Let us review them from the bottom up.

First, there was, and is, Pat. Harrington, who has been bridge inspector of the Boston & Albany and branches from Worcester to Chester for eight or nine years. He has "never learned the business of bridge-building," but he has learned the business of bridge-inspecting more effectually than any man we ever heard of, so far as we now recall. That certain peculiarities of his testimony did not attract attention is a striking proof of how such investigations often miss important points.

He swore positively that he "inspects bridges once a month, according to a regular system. When inspecting iron bridges examines all the rivets and waits for a train or two. Tests every rivet with a hammer, except for 3 or 4 ft. near the posts where it (what?) does not count. About all there is to do is to test the rivets and test the deflection. Tests the rivets in the stringers, floor beams and bottom laterals; tests at the intersections of the braces. It would take about three hours to test a bridge like this. He has inspected this bridge once a month. Did not go near the bridge while the men were at work on it. He has reported to Cady as master carpenter eight or nine years."

Now, it must be admitted that to do all this work (including the deflection tests and waiting for trains) on two 110-ft. spans in three hours was doing quick work, indeed; yet all the officers of the company and the commission sat by and never questioned this testimony. Since then we have taken steps to ascertain how many rivets there were in the structure, and by a computation leaving room for some minor errors only, we find that the number of rivets which Harrington swears he tested in three hours is about 7,600! Most of them, too, are on the top chord and under the floor timbers. To reach the former a man must do considerable hard climbing, while the latter can only be reached by a ladder from below. And yet, not allowing an instant for climbing, Harrington must have averaged over 42 rivets a minute to conform to his testimony.

Again, he testifies he took the deflection of the bridge under passing trains and found it to be from ⅜ to ½ in., and that, had he found it more than 1 in. he would have "considered it serious." But as he fixed his apparatus and waited for a train to come along it is almost absolutely certain that most, if not all, of the four deflections measured were taken with a train on one track only, and no one knows which track. Now, the idea occurs, if he measured a deflection of ½ in. in one case with a light train at low speed on the further track, might he not have obtained three or four times as much with heavy trains at high speed on both tracks? And if he had happened to strike such a combination, would he not have considered the bridge unsafe? Apparently, Mr. Harrington's ideas of the safety of a bridge are largely dependent on the conditions under which he happens to observe it. Is he, then, a safe man to be trusted with them? And if none of his superiors know enough about it to know whether Harrington knows his business or not, is it a very safe road to ride over? The only certain impression which remains on our mind after asking these questions is, that if any one wants to get a lightning rivet-tester, Harrington is their man.

We do not find any testimony in relation to the master carpenter, who was Harrington's immediate superior; but the next in the chain is W. G. C. Chamberlain, the company's bridge engineer, who testified that he had been in the profession 20 years; had both school and practical education; began with the Albany road in 1883, after having been connected with other roads and city work, and had been connected with bridgework since 1887; so that his entire connection with bridgework was on that road, a fact in no way to his discredit. He further testifies, however, that after he had prepared plans they were "approved by President Bliss, Engineer Russell and Assistant Shepard. Then they were sent to the Hawkins works. He had no supervision of the work by the Hawkins company, gave no directions about the work, and was not at the bridge when the work was in progress. Had several talks with J. D. Reed to be careful, but never gave any particulars about this bridge. The reputation of the Hawkins company is excellent, and it has done much work for the Albany road. No other company has been employed by the road since he has been with it."

Then, next comes Walter Shepard, Assistant Engineer. He is a graduate of the Institute of Technology, class of 1872. He testified rather obscurely that he "has nothing directly to do with the bridges on the road. Chamberlain has instructions to make plans for new bridges or strengthening, and he shows them to witness. Then they are sent to Mr. Russell. Witness signs the plans for the new bridges, but has not done so for strengthening bridges. The latter plans are submitted, same as those for new bridges. Had looked over this plan perhaps six years ago. Had no other connection with this bridge."

It would be held by most engineers, we fancy (at least we trust so), that if they had the responsibility of examining and approving all bridge plans, whether by signature or not, they had something very directly "to do with the bridges on the road" which threw a very direct responsibility upon them either to know that the carrying out of these plans was being properly supervised or to clear their skirts of all personal responsibility for the absence thereof. It is with the view of impressing this responsibility upon any who may heretofore have neglected it, as much as anything, that this article is written.

The commissioners find broadly, however, as will be seen by their report in another column, that "no officer or employee appears to have had more than casual knowledge of the condition of the bridge at any time while the work was in progress, or to have given any directions in regard to the work or the manner of doing it. In a word, there was no supervision of the work whatever on the part of the company." By clear implication of the testimony and findings, this had been habitually the case in all the bridgework done for the company in the 11 years or more during which it had been turned over in bulk to a single contractor, and he not an engineer by education or training, and not specially well known as a contractor outside of his immediate vicinage.

We venture to express the hope and the belief that such a case as this is absolutely beyond precedent as respects important companies having considerable quantities of work and heavy traffic to be handled over their bridges, and that it shows about the last extreme of criminal carelessness during a long period of years throughout the chain of officers, from President Bliss to Foreman Belville, inclusive.

In view of all these facts it seems to us that there is a substantial miscarriage of justice in such a wording of the findings as we report in another column; that is to say, in such a wording as leads all the Boston newspapers, for example, to head their reprints of the finding with "Belville to Blame. Responsible for the Chester Accident," or words to that effect, and to intimate in smaller letters only that the company also "should have exercised closer supervision." By any equitable standard Belville was the least to blame of all, since he was the most ignorant, and was only doing what he had been taught to do, even in his neglect to be careful just how he did anything. Where in the whole chain of officers was there any one who was careful as to how anything was done throughout all this long period of a dozen years or so? The commissioners argue in effect that because no prior accident of the kind occurred there could have been no prior carelessness. The argument is not sound. It is the nature of materials to stand abuse and overloading with amazing patience. All the probabilities favor the conclusion that the road has been upon the verge of similar disasters many times before, perhaps many times a year.

LETTERS TO THE EDITOR.

IRON BRIDGES VS. TORNADOES.

Sir: Referring to the letter of "T. C." in Engineering News, of Aug. 17 in regard to the effect of tornadoes on iron bridges I would state for his information that I know of two instances of iron bridges being destroyed by tornadoes, but as I have so little information in regard to both cases I have so far refrained from reporting them, hoping that some one who had more information would do so.

The first case is that of an iron highway bridge over the Conemaugh River near Blairsville, Pa. The bridge was of three or four spans of about 150 ft. each, and was destroyed in the summer of 1886, as near as I can remember. The entire bridge was lifted off the piers and deposited in the river about 50 ft. upstream, lying in almost a straight line across it, the pieces being very little bent or twisted. This bridge was constructed with inclined end posts, and the top chords of the different spans were connected. It was claimed by some that had these pieces been left out, all of the spans might not have been lost, but the position of the fallen spans in a straight line where they fell would indicate that they all felt the force of the wind alike. This was a new bridge, having been built but a year or two before. But little other damage was done in the vicinity. A few trees were blown down and a barn was unroofed, and that was about all.

The second instance is of the Maynard St. bridge, in Williamsport, Pa., the center span of which was destroyed by a tornado in the summer of 1891. This bridge was new, having been built to replace the one carried away by the June flood of 1889. The only other damage by this tornado was some slight damage to some buildings in South Williamsport.

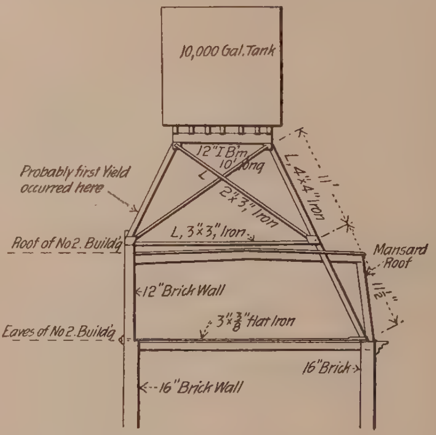
I have no information as to the theoretical strength of these bridges to resist the wind, but possibly the bridge companies who built them can give some information.

Both these disasters are authentic, having come under my personal observation, and from the fact that they both occurred in the East, out of the regular track of tornadoes, I think there must be other cases in the West that have not been reported. G. D. S.

New York, Sept. 23, 1893.

CONCERNING THE FAILURE OF A WATER TANK TRESTLE.

Sir: Referring to your issue of Sept. 14 and to the description there of the failure of a water tank trestle, it seems to me that this failure is fully explained by a consideration of elementary statics, without seeking further. Referring to the diagram, Fig. 1, such a trestle would theoretically be in equilibrium if the struts were of equal inclination, as each would exert a horizontal thrust at the ends of the 3 × 3 ins. angle tie, which would balance each other. If, however, the inclination of one strut was different from that of the other, these horizontal components would not be equal and would leave an unbalanced resultant, tending to move the trestle. With one of these struts vertical, or with its foot simply supported on an abutment, as in the trestle illustrated, the entire horizontal thrust of the other strut would be unresisted. This latter condition is exactly the case of the trestle in question, in which the horizontal thrust is one-quarter of the weight (for an inclination of 1 in 2), and is resisted only by the bending of the continuous leg, the friction on the abutment, and the resistance of the roofing material through which the continuous leg passes. As this thrust was fully 10 tons, and as there was no anchorage at the abutment, it seems to me that we need not look further for an explanation of this failure.



Elevation of Water Tank Trestle.

There is, however, little doubt but that compression members are frequently figured as "fixed" end pillars when the condition of their end connections in no wise justifies such an assumption. For instance, in the columns of high trestles, where, unless the strut and diagonal bracing connections at the various stories are unusually deep and rigid, the condition of the columns certainly does not approach that of a "fixed" end pillar, although it is stronger than one pinned at both ends. Other cases where pillar formulas are injudiciously applied can be easily enumerated. The trestle in question should, of course, have had diagonal bracing in the lower story, or the foot of the shorter leg should have been otherwise rigidly anchored.

Yours very truly, R. W. Hildreth.

New York, Sept. 21, 1893.

THE GOODMAN PLANIMETER.

Sir: I have just read Mr. Swensson's letter in your issue of Sept. 14 describing a novel planimeter. He does not state who the inventor was or how long it has been known; but it is identically the same instrument as invented several years ago by Professor Goodman, who was one of the English visitors to the recent Engineering Congress in Chicago. Professor Goodman exhibited his simple instrument at one of the sessions of the Congress of Engineering Educators, and he told me subsequently that he had just received his United States patent after a protracted correspondence with the Patent Office, where his demonstration of the principle did not seem to be understood. The instrument will be put on the market by Jackson Bros., Leeds. Professor Goodman claims that the only inaccuracy is due to scaling the distance between the two terminal positions of the blade. Will Mr. Swensson please give the history of the instrument as he knows it? Yours respectfully,

St. Louis, Mo., Sept. 20, 1893. Geo. H. Johnson.

DOUBLE-END EXPRESS LOCOMOTIVES.

Sir: In your review of my "Locomotive Catechism," in your issue of July 20, you state that what I give as an illustration of an express passenger engine with two pony trucks is properly a double-ended suburban engine. Permit me to call your attention to the fact that this arrangement (which is what I advocated and illustrated some years ago in the "American Journal of Railway Appliances" for an express passenger engine to make the trip between New York and Chicago in 18 hours) is given by the Baldwin Locomotive Works on page 15 of their catalogue of locomotive details as "Class 8¼ C for express passenger service." The cut was furnished me by the Baldwins. Kindly make the correction. Very truly,

Robert Grimshaw.

New York, N. Y., Aug. 25.

(There is no correction to make. We stated that the cut of express engine with pony trucks, "while correct as to arrangement of wheels," represents a double-end suburban engine. This statement is perfectly correct. The Baldwin double-end express engines have been described and illustrated in our issues of June 15 and Aug. 3, 1893.—Ed.)

NOTES AND QUERIES.

S. W. B., Jr., New Orleans, La., asks for the address of the makers of steel caps for driving piles.

G. G. T., of Frostburg, Md., says he has a brick-lined tunnel on the railway in his charge, in which the brickwork is crumbling from the action of frost and water. He proposes to put in a lining of wrought iron, with cement mortar between the plates and brickwork. He asks if this is the best remedy, short of removing the brickwork, and also whether rubber or similar material should be placed between the top flanges, where the boiler-plates connect, to allow for expansion and contraction. We should say that under the circumstances the iron lining was the best remedy. But it will have to be taken care of to prevent corrosion by the contact of gas and steam. The best advice on this protection that we know of is contained in a paper read by Mr. J. G. Dagron before the American Society of Civil Engineers, published with the discussion upon it, in the "Transactions" of the Society for September, 1892. (Engineering News, Nov. 17, 1892). In this case the iron was covered with two coats of asphalt paint. Galvanized iron is soon worn out as a rule, and its use is generally abandoned on railway structures. In some cases a wood lining might be used when the conditions are such as to keep it damp; but it would require rather frequent renewal. The paper referred to can be obtained by applying to the secretary of the Am. Soc. C. E., 127 East 23d St., New York. We are very doubtful as to the rubber. It will decay and be of little service. Three or four longitudinal joints would be better than one at the crown, and would make it easier to hold the plates in position.

SPENCE'S METAL.

In answer to queries we describe the somewhat new metallic compound known as Spence's metal, making for this purpose a brief abstract of the paper read in 1880 before the English Society of Arts, by Mr. Granville Cole, Ph. D.

The discovery was made about 1879 by Mr. J. Berger Spence that the sulphides of metals, combined with molten sulphur, formed a liquid. This liquid on cooling became a solid, homogeneous mass, possessing great tenacity and having a peculiar dark-gray—almost a black—color. According to experiments made, nearly every metallic sulphide known combines with an excess of sulphur, and nearly all these combinations have the same properties.

Mr. Spence exhibited a combination consisting of an ore of iron pyrites containing both lead and zinc sulphides. A short summary of its peculiarities is given as follows: A comparatively low melting point, viz., 320° Fahr. It expands upon cooling, a property only shared among other metallic compounds by type-metal and bismuth, and for this reason excellently adapted to joining water and gas pipes. It is claimed to resist atmospheric and climatic influences. It is superior to other metals in its resistance to acids, alkalies and water. It has a smooth surface and takes a high polish. It is one-third the weight of lead, and a ton of Spence metal was worth $75 as compared with $90 for lead, in 1880.

Mr. Cole does not go into the detail of its manufacture at all, but especially recommends it for use in calking water and gas pipe and in chemical works. He closes his lecture by saying that Mr. Spence, in 1880 was still engaged in making extensive experiments with the metal at his works, at Belvedere, Kent County, England.

We believe that it is a commercial article, but cannot find it advertised for sale in American or English papers. If any of our readers know more of it, will they kindly inform us for the benefit of our correspondents.

FOREIGN LOCOMOTIVES AND CARS AT THE COLUMBIAN EXPOSITION.

In locomotives, France and Canada are the only foreign countries which have a representative exhibit, and in cars the foreign exhibits (with the exception of Canada) are very meager. It is a pity that this should be so, especially as the American exhibits of engines and cars are so numerous and comprehensive. Canada we must include as a foreign country, but its railway exhibit is so thoroughly on American principles that it might well represent American practice.

England.

The English railway exhibit consists mainly of three locomotives and two cars; but not one of the locomotives can be considered as representative of standard English practice, for one is an old 7-ft. gage engine, built in 1846 (but in service until 1881), another is a new type of the Webb three-cylinder compound, and the third is an engine of entirely new and untried design, which is little more than an interesting novelty.

Great Western Railway.—This railway exhibits the famous engine "Lord of the Isles," built for the 7-ft. gage which was first introduced on this railway, and which only became obsolete in May, 1892. This engine has a single pair of driving wheels 8 ft. in diameter with blind tires and a crank axle for inside connections. This engine was built in 1846 at the railway company's works, at Swindon, from the designs of Mr. (afterward Sir Daniel) Gooch, and engines of the same type were employed for hauling the express trains between London and Newton Abbot up to May, 1892. The engine was one of the important railway exhibits and attractions at the first international exhibition, at London, in 1851, and continued at work until July, 1881, running a total of 789,300 miles. There is no dome, steam being taken from a horizontal pipe in the steam space, an arrangement now abandoned. It is a handsome and well proportioned engine, and is a credit to its early designers.

London & Northwestern Railway.—The fine express locomotive "Queen-Empress," exhibited by this road, is a three-cylinder compound engine on the system invented by Mr. F. W. Webb, Locomotive Superintendent, and described in our issue of Jan. 26, 1889. The system is quite extensively used on this road, but is not favorably considered by many engineers, and little reliance appears to be placed upon the fuel economy claimed for it, while it is said by English engineers that the bulk of the fast and heavy traffic on the road is handled by simple engines. A Webb compound engine has been in service on the Pennsylvania R. R. for some time, and is said to have given satisfactory results, although no official figures of the performance have been published. A novel feature in the engine on exhibition is the use of a boiler barrel 18 ft. 6 ins. long, with a combustion chamber breaking up the continuity of the tubes. The tubes from the firebox to the combustion chamber are 5 ft. 10½ ins. long, and these from the chamber to the smokebox are 10 ft. 1 in. long. A hopper bottom with air-tight doors is fitted to the bottom of the combustion chamber, but this chamber seems more likely to act as a cinder catcher than to afford any aid to combustion. A sister engine, the "Greater Britain," was run in continuous service for six days in April last with fast and heavy trains between London and Carlisle, making a mileage of 3,612 miles (24 miles light), at an average speed of 47.66 miles per hour, with an average weight of train of 359,296 lbs., or 532,000 lbs. inclusive of engine and tender. The trips amounted to 852,244 ton-miles, including engine and tender, and the actual coal consumption is given as 29.87 lbs. per mile. The two cars behind the "Queen-Empress" are a sleeping saloon and a standard composite car, and are both very elaborately finished and fitted. They were described in our issue of March 23. Like too many American sleeping cars, the interior is finished in very dark colors, but the cars are ahead of American practice in the use of exhaust ventilators. The cars have monitor roofs and are lighted with compressed gas on the Pope system, but are narrow, low and cramped, as compared with American cars, owing to the smaller limits of English tunnels, bridges, etc.

The singular engine, "James Toleman," exhibited by Westwood & Winby, of London (and built by R. & W. Hawthorn, Leslie & Co., of Newcastle, England), was described in our issue of April 13, 1893, and is an eight-wheel engine with four high-pressure cylinders and a flat sided boiler. As the engine is the first of its kind, and has never been in regular service, it is exhibited by its inventor, Mr. Winby, who is said to believe it superior to the compound system, in which he is very much mistaken, and it seems very doubtful whether in heavy service the boiler could furnish steam for the four cylinders.

The following table gives some of the principal dimensions of these three English locomotives:

	G. W. Ry.	L. & N.W. Ry.	Winby's.
Driving wh'els, dia.	8 ft. 0 ins.	7 ft. 1 in.	7 ft. 6 ins.
Wheelbase, driving.	....	8 ft. 3 ins.	11 ft. 4½ ins.
" total....	19 ft. 0 ins.	23 ft. 8 ins.	23 ft. 8 ins.
Weight on drivers .	35,840 lbs.	69.440 lbs.	80,640 lbs.
Weight, total.......	93,408 lbs.	116,704 lbs.	134,000 lbs.
Cylinders.........	18 × 24 ins.	Ins. O (2) 15 × 24 I (1) 30 × 24	Ins. (2) 17 × 22 (2) 16½ × 24
Boiler barrel, l'gth.	10 ft. 9 ins.	18 ft. 6 ins.	8 ft. 2½ ins.
" " dia .	4 ft. 9 ins.	4 ft. 3 ins.	4 ft. 2 ins. × 5 ft. 7 ins.
Firebox, length....	5 ft. 6 ins.	6 ft. 10 ins.	8 ft. 3¾ ins.
" width....	6 ft. 0 ins.	3 ft. 10 ins.	3 ft. 4½ ins.
Grate area....	25.46 sq. ft.	20.5 sq. ft.	28 sq. ft.
Tubes, number....	300	156	237
" out. dia....	2 ins.	2⅛ ins.	2 ins.
" length.....	11 ft. 1 in.	5 ft. 10½ ins. 10 ft. 1 ins.	14 ft.
Heating surface, tubes...........	1,611 sq. ft.	853.0 sq. ft. 493.0 sq. ft.	....
Heating surface, comb. chamb..	....	39.1 sq. ft.	....
Heating surface, firebox..........	156 sq. ft.	120.6 sq. ft.	....
Heating surface, total...........	1,767 sq. ft.	1,507.7 sq. ft.	2,050 sq. ft.
Boiler pressure...	120 lbs.	175 lbs.	....

France.

The French railway exhibit includes four locomotives and a double-deck suburban car, all of which represent standard designs and have been in regular service before being put on exhibition. All of the engines have steel plate frames, wrought iron wheels, brass or steel tubes and copper fireboxes, and one of them has a four-wheel truck, an arrangement which is gradually replacing the fixed or radial leading axle of many European engines. One of the engines is a four-cylinder compound, a system which has been tried on all the principal railways of France and is likely to become standard for passenger and freight service there.

Northern Railway.—This railway exhibits a handsome four-cylinder compound express engine of the American eight-wheel type. It was built in 1891 by the Societe Alsacienne de Constructions Mecaniques, of Belfort, and has a record of 65,000 miles from Oct. 19, 1891, to Feb. 1, 1893. The high-pressure cylinders are outside, behind the truck, working the rear drivers, and having the Walschaert valve gear (reaching too near the rail level) and steam chests on top of the cylinders. The low-pressure cylinders are inside, under the smokebox, and work the front drivers by a crank axle with hooped cranks. The link valve gear is used and the steam chests are between the cylinders and frames. Unlike the Webb three-cylinder compound, this French engine has side rods connecting the front and rear drivers, and both the main and side rods are of I-section. The driver springs are underhung, and are not equalized, though some other French railways use the equalizing system. The boiler has a Belpaire firebox between the driving axles, and the dome is just in front of the firebox. The engine has a steam-jet sanding device, driver brakes and two injectors. The cab is of the usual type on European locomotives, with short sides and roof, and no seats. As the climate is not severe, the French enginemen and firemen object to the partly inclosed cabs adopted on some roads, but whether they actually prefer to stand up at their work we are not informed. The footplate is but little above the centers of the wheels and has a wooden platform on small plate springs to relieve the men of the jar of the engine. Wooden plates fitted to the steps of the cab and on the truck are a decidedly good idea. In regular service this engine makes runs at a mean speed of 70 miles per hour, with a 200-ton train behind the tender.

State Railways.—The railway administration exhibits a double-end, four-coupled, outside cylinder express engine, which was built by the Compagnie de Fives-Lille, in 1892. It has a single pair of solid plate leading wheels and a single pair of spoke trailing wheels. The latter have end play, but not enough for the curves of American railways, so that these wheels had to be taken off in hauling the engine to Chicago. The valve gear is of a special type (Bonnefond patent) which has been experimented with for some time on the State Railways. It has a detachable cut-off, with two steam valves above and two exhaust valves below the cylinder. The gear appears to be complicated and liable to disarrangement, but Mr. Demoulin, the technical delegate from the French railways (to whom we are indebted for information), informs us that it has given satisfactory results and has been fitted to eight engines of this class. It seems doubtful, however, whether any sufficient gain in efficiency or economy is obtained to warrant the use of such a gear for locomotives.

The engine is fitted with a variable exhaust nozzle and the smokestack has a vertical damper in front of the opening at the top, to reduce back pressure from the wind. It has a Wenger brake pump, but no driver brakes.

Western Railway.—This railway exhibits a compact six-wheel tank engine of the type used for the heavy Paris suburban traffic. It was built by the Societe Franco-Belge, of Raismes, near Valenciennes, and is representative of a type very extensively used in France and England. The wheelbase is short, to enable the engine to be turned on the hydraulic turntables at the St. Lazare terminal station, in Paris. The cylinders are inside and inclined, placed under the smokebox, with valve chests below the cylinders, the valve rods passing under the leading axle. The side rods are of lighter section, but it is said that breakages are very rare. The firebox is between the middle and rear axles, and as there is little overhang the engines work very steadily. The firebox has an inclined grate, firebrick arch and a deflector on the door. The tanks are on the running board, at the side of the boiler, an arragement little used in this country, and have a capacity of 880 gallons. The engine is fitted with Westinghouse brake and brakeshoes on all driving wheels.

The railway company also exhibits one of its standard four-wheel double-deck cars used on the Paris suburban lines only, although many visitors get the idea that these cars are used in main line service. The car was built by Carels Freres, of Le Mans, and is for second-class traffic, with four compartments in the body and five open narrower compartments above. The roof is reached by stairs from each corner of the car. It weighs 20,160 lbs. and can seat 75 passengers, which gives a dead load of but 250 lbs. per passenger. The frames are of channel iron. The wheels are of the Arbel pattern with solid plate face backed by radial spoke ribs. The car is dimly lighted by two oil lamps, which are kept lighted most of the time, as much of the run is in tunnel. As the smokejacks are below the seats of the upper deck, the smoke and smell from these lamps, combined with the cinders from the engine and the very low roof, make the upper deck, or "imperial," less pleasant than might appear at first glance. Nevertheless, it is very popular, and it enables the railway to handle a very heavy traffic. On Sundays, racedays and holidays over 300,000 persons a day are carried. A six-coupled tank engine of the type above described can haul 30 of these cars, or a train-load of 2,250 passengers seated.

Paris & Orleans Railway.—The engine of this railway is exhibited by the builders, the Societe Franco-Belge. It is an inside cylinder tank engine with six drivers, and is of the same general type as the Western Railway engine, above described. The steel plate frames are outside the wheels, and the side rods are carried upon heavy crankarms. The side rods are fish-bellied, and of I-section, with ball and socket bearings to allow for lateral play of the leading axle. The leading tires are fitted with lubricators to ease the motion on curves, and the axle has lateral play and inclined guides to the boxes for the same purpose. The firebox has an inclined grate, hopper door, a Ten-Brinck water table and a crown of the Polonceau system. A variable exhaust nozzle is used. There are two large steam domes, with a connecting pipe which passes through the sandbox.

The leading dimensions of these four French locomotives are given in the accompanying table:

	Northern Ry. Eight-wheel. ft. ins.	State Rys. Double-end. ft. ins.	Western Ry. tank. ft. ins.	Paris & Orleans Ry. tank. ft. ins.
Driv. wheels, diam......	6 11	6 7⅛	5 0½	5 2⅛
Leading wheels.....	......	4 4⅛	5 0½	5 2⅛
Trailing wheels	......	3 8	5 0½	5 2⅛
Wheel base..	24 5	19 8½	14 7	14 11
Weight on drivers. ...	......	63,728 lbs.	91,520 lbs.	105,280 lbs.
Weight in working order......	107,072 lbs.	103,096 "	91,520 "	105,280 "
Cylinders..	ins. (2) 13⅗×25⅗ (2) 21⅛×25⅗	ins. 17.6×26	ins. 17×23⅝	ins. 17¾×25½
Steam pressure........	205 lbs.	185 lbs.	185 lbs.	185 lbs.
Firebox, length......	......	6 ft. 3⅝ ins.	4 ft. 1½ ins.	5 ft. 10¾ ins.
Firebox, width......	......	3 " 3⅝ "	3 " 5¾ "	3 " 3⅝ "
Grate area...	22 sq. ft.	20.8 sq. ft.	13.8 sq. ft.	19.8 sq. ft.
Tubes, number	......	158	205	209
Tubes, out. diam.	......	2 ins.	1¹⁄₁₆ ins.	1⅝ ins.
Tubes, length	......	16 ft. 3⅛ ins.	10 ft. 5⅞ ins.	12 ft. 5½ ins.
Heating surface, tubes.	......	1,192.9 sq. ft.	953.7 sq. ft.	1,139.7 sq. ft.
Heating surface, firebox ...	......	101.7 "	81.8 "	130.0 "
Heating surface, total.	1,212 sq. ft.	1,294.6 "	1,035.5 "	1,269.7 "

Besides the locomotives and cars the French railway exhibit includes some other exhibits of interest:

The Western Ry. exhibits a large model of the Saint Lazare terminal station, at Paris, which has 30 tracks and 28 platforms, and handles about 20,000,000 passengers yearly. On June 11, 1893, there were 320 passenger trains in and out, carrying 312,000 passengers. There are also large and finely executed drawings of the very complete hydraulic plant for operating the turntables, switching, hoisting baggage by inclined elevators from the street to the platform, and for lifting freight cars in a two-story freight station. The pumping plant is about two miles from the railway station.

Mr. Arbel, of the Forges de Couzon, with offices in Paris, has a very interesting display of wrought iron locomotive and car wheels artistically arranged and displaying some excellent workmanship. Many of the wheels have been in service for some years. Mr. Arbel has patented a new process for the manufacture of wrought iron car wheels at low cost, and exhibits a new pattern of a light and strong forged car wheel, having a disk face with radial spoke ribs at the back, supporting the tire. The Paris & Orleans Ry. tested one of these by forcing it off the axle, and it required 160 blows of a 44,000-lb. steam hammer, falling 8 ins. The plate face was dished 2¾ ins. toward the outside, but there was no sign of crack or breakage. The Compagnie de Fives-Lille has photographs of locomotives, and drawings of an air-brake system for long freight trains. Mr. A. Mallet, the practical originator of the two-cylinder compound locomotive, shows photographs and drawings of his engines. Mr. Pellat, of Paris, has a model of an electric apparatus with track connections, by which the relative position of trains is automatically registered upon a moving strip of paper in the train dispatcher's office. Mr. Henard, of Paris, shows drawings of a movable sidewalk (one speed only, in which it differs from the American movable sidewalk or multiple-dispatch railway) originally designed for use at the Paris Exposition of 1889. Mr. J. H. Digeon, of Paris, has large scale drawings of two interesting examples of railway plant. One of these is a four-wheel dynamometer car which was equipped for the Western Railway in 1889, exhibited at the Paris exposition, and has since been in service. Two similar cars have been built for the Southwest Railway, of Russia, and the Hungarian State Railways. The other drawing represents a hydrostatic weighing machine for locomotives which records the load upon each wheel. The machine has been built for the Western Railway of France, and it is proposed to introduce the system in this country.

Germany.

The German exhibit includes two engines, two passenger cars and two freight cars of the Prussian State Railways. One of the locomotives is a six-wheel, two-cylinder compound freight engine, built in 1892 by F. Schichau, of Elbing, Prussia. The cylinders are outside, 18.4 and 26 ins. diameter, both lagged to the same outside diameter. The main and side rods are flat and of light section, with solid ends fitted with brass wedges set up by screws. The other engine is a small six-wheel tank engine with inclosed cab, built by Henschel & Son, of Cassel. The cylinders are horizontal and outside, with inclined valve chests on top, and the link valve gear outside the wheels, which in turn are outside the frames. Water lubrication pipes are led to the front driving tires. The engine is fitted with Westinghouse brake, and brakeshoes on main and rear drivers.

The "special first-class" car of the Wiesbaden branch railway is on the American plan, but with fixed seats back to back as in a sleeping car. The sides of the car are of steel plate. The ordinary compartment car shows the gradual improvement being made in European rolling stock in that it is fitted with lavatories, but two lavatories to four passenger compartments is a most wasteful arrangement of space. The cars are lighted by the Pintsch compressed gas system and heated by steam, with a valve for regulating the heat in each compartment. An iron coal car with buckle-plate sides, and a long flat car for timber, with pressed steel stakes in stake pockets, are exhibited by Van Der Zypen & Charlier, of Cologne. They have each channel iron frames and spoke wheels without brakes. The same firm built the Weisbaden car, while the compartment car was built by the Breslau Railway Car Works.

Canada.

Canada long ago adopted American principles and practice in locomotive and rolling stock equipment, and one of the most magnificent exhibits is that of the Canadian Pacific Ry., which has already been described in our issue of May 25. The five cars are all vestibuled, and engine and cars were built at the company's shops, in Montreal.

The interior finish of the cars is very handsome, and the simplicity of style compares most favorably with the extravangance of ornateness displayed in the American palace cars of Pullman and Wagner. The use of heavy square columns in the first-class car, merely to break up the perspective, has a clumsy effect, and the continuous baggage rack is also unnecessarily heavy in design, while the use of tapestry lining for staterooms is to be deprecated, in view of the dust and dirt of a transcontinental journey. The principal dimensions of the cars are as follows:

	Length. ft.	ins.	Weight.	Trucks.	Capacity, seats.
Baggage car..........	63	8	59,600	6-wheel	..
Colonist sleeping car..	64	4	65,300	4-wheel	64
First class day car....	64	4	65,300	4-wheel	56
Dining car.............	70	10	85,000	6-wheel	30
First class sleep. car	77	2	94,000	6-wheel	24

The engine is a fine specimen of modern locomotive construction. The drawings of this type of engine were published in our issue of Aug. 30, 1890. The general dimensions of the engine are as follows:

Driving wheels, diam.........................	5 ft., 9 ins.
Cylinders....................................	19 × 24 ins.
Weight of engine and tender.....	213,000 lbs.
Length over engine and tender................	59 ft., 8 ins.
Capacity of tender tank........................	3,000 gals.

Argentine Republic.

The car "El Cacique," built for the use of the officials of the Bahia Blanca & Northeastern Ry., by the Harlan & Hollingsworth Co., of Wilmington, Del., is more a specimen of American than foreign style. It has an observation-room at each end, saloon, lavatories, etc., with end platforms and doors, and is carried upon a pair of ordinary four-wheel passenger trucks with wooden frames and cast iron wheels It is, however, fitted with the English pattern of spring buffers and screw-and-link couplings.

Russia.

In the Russian section of the Transportation Building is a model of an arrangement patented by Mr. B. Gunzburg, C. E., for converting the ordinary day cars into sleeping cars without decreasing the capacity; that is to say, the sleeping capacity is equal to the seating capacity. The Russian day cars are arranged like American sleeping cars, with a central aisle and fixed seats back to back, but having fixed partitions between the sections. Each section seats four persons. The lower berths are formed by turning over the seats, which are hinged at the front, thus filling the space between the two seats. The upper berths are formed by panels hinged at the top, which in the daytime lie against the partition, and at night are swung up, and secured by brackets at the side of the car and by hangers from the roof. Each upper and lower berth accommodates two persons, and each person's berth is independent, so that some can sit up and others sleep in the same section without inconvenience. The third-class cars are not upholstered, and passengers supply their own bedding. The second-class cars are upholstered, and the conductor supplies blankets, etc. The system has been in use since 1890; and in October, 1892, the Manager of the Transcaspian Railway reported that it had five second-class and ten third-class cars fitted up on this system, and found them very satisfactory for through service, the line being 1,344 miles long. The Russian Government Railways, the Kharkoff & Nikolaeff Railway, the Transcaucasian Railway and others, have also commenced to transform some of their ordinary cars into sleeping cars on the Gunzburg system, and it is hoped to introduce it upon some of the Indian railways. The cost of alteration is small, and the cost of a new car but slightly in excess of that of a day car. The system presents several advantages, an important one being the absence of overhead berths during the day, and the arrangement appears to be specially adapted for emigrant, colonist and second-class traffic. Mr. Gunzburg has patented his invention in this country, and is undertaking its introduction here.

THE ADMINISTRATION BUILDING AT THE COLUMBIAN EXPOSITION.

(With inset.)

We show on our inset sheet this week a perspective view of the Administration Building, at the Columbian Exposition, which is generally agreed to be one of the architectural gems of the Fair. Our engraving is reproduced direct from a photograph which shows the graceful building from, perhaps, the most favorable position. We are indebted to the publishers of "Architecture and Building" for the use of the lithograph stone from which our engraving is printed.

THE CHESTER BRIDGE DISASTER.

The following is a substantially complete reprint of the finding of the Massachusetts State Board of Railroad Commissioners on the bridge disaster at Chester, Mass., Aug. 31, by which 14 persons were killed and some 35 or 40 injured. We abstracted the testimony in the case two weeks ago, and comment on the finding in another column:

The bridge was built in 1874 by the Niagara Bridge Co., of Buffalo, N. Y., on plans prepared or approved by Mr. Edward S. Philbrick, an engineer of distinction in his day, not now living. It was an iron double-track "through" bridge of two spans, each 104½ ft. in clear length, with two trusses for each span. It had always been regarded by the experts of the company as a good and safe bridge, of ample strength for the traffic passing over it. It had required only the ordinary attention and repairs of bridges of its class.

It was inspected monthly by the bridge inspector of the division, and a few weeks before the accident had stood satisfactorily the usual tests for deflection under the load of passing trains. It had given no signs of structural weakness or deterioration, and up to the present summer had not received or required alteration or strengthening.

After the passage of the act of 1887, Chapter 334, providing for the "examination of railroad bridges," complete plans of this bridge were filed in the office of the board, and three biennial reports of inspection by an engineer of the railroad company have since been received, all as is required by that act. The plans and reports submitted have been carefully examined by Professor Swain, who has also several times examined the bridge in person. In a report made June 15, 1891, he stated that the floor of the bridge was light for consolidation engines, and that it should be strengthened before such engines were allowed to run over it. A copy of this report was sent (as is the custom) to the company. This was the only recommendation which Professor Swain had made regarding this bridge. He had not deemed it necessary in 1891 to recommend the strengthening of the trusses.

In view of the heavier engines which the Boston & Albany has since introduced he was this year re-examining the plans and revising his computations, but had not as yet completed his report on the main line bridges of this road or made any recommendations respecting the trusses of this particular bridge. During the last winter or spring, in view of the intended use of the heavy consolidation and 10-wheel passenger engines on the section of road between Springfield and Pittsfield, in which this bridge lies, the president of the company directed its bridge engineer to prepare plans for strengthening the bridge floor. He also decided, upon second thought, to strengthen the trusses as well as the floor system during the present year, and gave directions accordingly. The plans, as prepared and approved, were designed to bring the strength of this bridge up to the standard of the Boston & Albany for new bridges, over which its heaviest freight and passenger engines are intended to be run.

The work proposed, it is to be noted, was not a work of repair, or of the substitution of new for old parts which were worn out or decayed. It was wholly a work of strengthening, and consisted chiefly in the addition of more iron plates to those already forming a part of the structure of the bridge.

It may as well be stated here that the work of strengthening the floor system had been completed about a month before the accident occurred.

As soon as the iron work of the floor was far enough advanced the master carpenter of the division had relaid the tracks across the bridge on new, hard pine ties of increased size.

There seems to be no room for question that the bridge floor and tracks were in excellent condition when the bridge went down.

Professor Swain had not carefully examined the plans for strengthening the bridge, but he testified at the hearings that, upon such examination as he had given them, he had no hesitation in saying that the company had more than complied with his recommendation in regard to strengthening the floor system, and that the work on the trusses, which was in progress when the accident occurred, would have been, when completed, more than a compliance with any recommendation which he might probably have deemed it necessary to make for strengthening the latter.

Not until after the floor of the bridge had been strengthened, as above stated, had either consolidation engines or the two 65-ton passenger engines, one of which was drawing the wrecked train, been used in train service over this bridge; nor had any engine, freight or passenger, of over 45 tons weight been so used. The recommendation of Professor Swain had in this respect also been fully observed.

For some years past all of the bridge work of the Boston & Albany has been done by Mr. Hawkins under a standing or general contract, which was made orally with him by Mr. Bliss, the president of the company. By the terms of this contract Mr. Hawkins was to do all required bridge work at so much per pound for material erected and so much per day for work in erecting the material and for use of tools. All material was to be of the best quality, and all work was to be done in the best manner, in conformity with the plans furnished by the railroad company. The prices per pound or per day were modified from year to year, as changes in current market rates demanded.

Mr. Bliss testified that the prices agreed on from time to time were such as to call for first-class material and workmanship; and that his reason for basing the contract on the amount of material and labor actually furnished was that there should be no inducement to scant either the one or the other.

All of the evidence tended to show that the iron bridge work whch had been done by Mr. Hawkins for the Boston & Albany for a continuous period of nearly 20 years had been done to the satisfaction of the company; that there had been no complaint of improper work, or of the slighting of work, or of carelessness in the matter of doing it; and that no accident or mishap had ever before occurred in connection with his work.

It is a fair and just inference from all the testimony that Mr. Bliss believed, with entire confidence and good faith, that Mr. Hawkins was "a most careful, competent and painstaking man," who felt an interest and pride in the work done for the company, almost, if not quite, equal to his own; and that Mr. Hawkins would not have been employed to do the work of the company for so long a series of years if there had been good reasons to the contrary.

The bridge material is prepared at the shops of Mr. Hawkins in Springfield in such dimensions and detail as the plans call for and is sent out in this shape to the place where it is to be used. The erection of the material is in the charge of outside superintendents, so called.

One of these, Mr. J. Dana Reed, was superintendent of this year's work on the 18 bridges between Springfield and Pittsfield, before mentioned, including the wrecked bridge.

At the date of the accident the work on 11 of these bridges had been completed; was in progress on three of them, including this bridge, and Mr. Reed was taking measurements for work on still others.

It was Mr. Reed's duty to see that all of this work was done, and properly done, but he was not expected to supervise in person the actual doing of the work. It does not appear that he visited the fated bridge but once during the 3½ days preceding the accident, and then only for 10 or 15 minutes on the afternoon of the previous day to tell his foreman that some material was about to arrive. He employed a foreman and gang of men for each bridge. The foreman was subject to his orders and the men were subject to the orders of the foreman. There were 13 men at work on this bridge. The foreman was one Daniel Belvilie, and he had the immediate charge and direction of the work at the time of the accident.

Such was the supervision of the work on the part of the Hawkins Iron Works. What supervision did the railroad company exercise?

Its bridge engineer, Mr. Chamberlain, had the special charge of the bridge department for the whole road.

It was one of his duties, as directed, to prepare plans for bridge work, which, after approval by the chief engineer or his assistant and by the president, were sent to the Hawkins Iron Works for execution.

Beyond making necessary explanations of the plans, from time to time, his duty ceased there. He had in this way occasionally met and talked with Mr. Reed, and had advised him to be careful about such work, but had given him no specific directions how to do it.

It was not his business to supervise work in the field, and he had not visited this bridge at any time since the work on it had begun.

The master carpenter and bridge builder and the bridge inspector of the division seem to have understood, whether rightly or not, that their functions with respect to the bridge were suspended while it was in the hands of the Hawkins workmen, and that they had no business in any way to meddle with it.

No official or employee of the railroad company appears to have had any more than a casual knowledge of the condition of the bridge at any time while the work was in progress, or to have given any directions in regard to the work or the manner of doing it, or to have had any special charge of the running of trains over the bridge while the work was going on.

In a word, there was no supervision of the work whatever on the part of the railway company.

The work does not demand any high degree of mechanical knowledge or skill. Under proper direction it can be performed, as it was in this case, by an ordinary gang of riveters, with common laborers and helpers. But the work must be done with due precaution, and in the right way.

The usual and proper method, roughly described, is understood to be this: In putting additional cover-plates on the posts or chord of a truss, with a view to strengthening it, as was here doing, the rivets which hold the old plates in position have to be first taken out. As this tends to weaken the truss, the rivet holes, as fast as the old rivets are removed, should be filled temporarily with bolts or drift pins.

The new plate is then laid in position on the old, and, beginning at one end of the plate and advancing step by step toward the other, the two plates are both riveted down through the corresponding holes in each, the bolts and drift pins being removed from the old plate as fast as the new rivets are driven, or the two plates may be temporarily secured by putting in another set of bolts and drift pins extending through both plates, proceeding step by step as before, until the final riveting can be conveniently done.

What was the condition of the bridge when Foreman Belville left it? Belville told his story, and his workmen told their stories, all under oath. It is not worth while to repeat them. The true story was told by the bridge itself.

In brief, it was found that at the southwesterly corner of the bridge the cover plates, both old and new, of the truss chord in question, for a length of 25 ft. or more at the place where the men were last working on it, were not fastened to the chord or to each other by either rivets, bolts or drift pins; and that they had in fact slipped off from the chord as the truss was canted over in the fall of the bridge, and were lying elsewhere in the river bed.

It was found, besides, that the lateral braces were wholly disconnected from the top chords of both trusses at three or four joints or panel points at the extreme west end of the bridge, thus further weakening the bridge. At the critical point, the condition in which the bridge was thus found was unquestionably in these particulars, its condition at the time when Belville walked across it on the way to his dinner.

Upon the testimony of all the witnesses, both expert and practical, and as a matter of common judgment, it cannot be believed or reasonably conjectured that there had been rivets or bolts or drift pins in these plates and braces when the bridge went down, and that they had been broken or wrenched out in its fall.

At the best, the rivets, bolts or pins, if any, had been so very few as to be of no service. The number of empty rivet holes, according to Superintendent Reed, was not less than 150.

There is not, therefore, a shadow of doubt as to the immediate cause, and (so far as appears) the only physical cause, of the collapse of the bridge.

The bridge had thus been radically and fatally weakened. As soon as the head of the train with its ponderous engine was fairly on the bridge, the west span, beginning at the point in the dismantled truss chord which has been described, began to give way and to fall into the river toward the south.

By the time the engine had crossed the central pier the combination baggage and buffet car next behind had tipped over so far in the same direction as to strike the westerly endpost of the southerly truss of the east span of the bridge with a force sufficient to bend and tear the post out of the end of the truss. This truss then gave way, causing the east span also to collapse and to fall into the river toward the south.

Upon the whole we must conclude that the train was probably going not less than 35 miles an hour when it reached the bridge. This was not an improper speed, assuming the bridge to be in a safe condition. Nor can it be said that the speed of the train was the cause or even a contributing cause to the collapse of the bridge.

It has been the attempt thus far to state the facts, and to state them fairly as well as fully. It remains to draw such conclusions as the facts seem to warrant and require. The board finds:

1. That the bridge as originally built was a safe bridge, of sufficient strength for all the traffic which had been done over it up to the time when the recent work was begun.

2. That the railroad company had made seasonable provision for strengthening the bridge up to the standard required for the heaviest rolling stock now in use on its road; and that the plans which had been prepared and approved, and which had been executed as regards

the floor system and were in process of execution as regards the trusses of the bridge, were ample for that purpose.

3. That the bridge on the day of the accident, in its normal condition, was of adequate strength for all the engines and trains which were at that time in use on this section of the road, including the wrecked engine and train.

4. That the collapse of the bridge was caused by the unnecessary and dangerous weakening of the top chord of the southwesterly truss of the bridge, in the manner which has been described by the workmen who were engaged in the work of strengthening the trusses.

5. That the immediate responsibility for the disaster rests upon Daniel Belville, the foreman, who had the charge and direction of the work, and who, on this day, recklessly allowed the work to be done by improper methods, and the bridge to be left in an utterly unsafe condition, and heedlessly neglected to warn the coming train.

6. That no blame attaches to the conductor, engineer or other trainmen of the wrecked train.

7 .That the speed of the train was not the cause nor, properly speaking, a contributing cause to the collapse of the bridge.

8. That the contract made by the president of the railroad company with the proprietor of the R. F. Hawkins Iron Works, under which the work on this and other bridges was done, was designed and adapted to secure the best material and workmanship; that the confidence of President Bliss in Mr. Hawkins as an experienced and competent bridge builder and worker was well grounded, and that Mr. Hawkins desired and intended to do all such work for the company in the best and most satisfactory manner; but that it was not wise or proper for the railroad company to devolve upon Mr. Hawkins and his employees, or to allow him or them to assume or exercise in the execution of work under the contract, any of the duties and responsibilities of its own officers and servants with respect to the security of the bridge and the safety of travel over it.

9. That there was in this case a serious and, as it proved, a fatal neglect or omission on the part of the railroad company to provide a competent supervisor or inspector, employed by and directly responsible to itself, to see that the bridge was at all times during the progress of the work in a safe condition for the passage of trains, and, in case it should be at any time unsafe, to give due warning and to prevent such passage until the bridge had been made safe. If such supervision or inspection had been exercised in the present case, the disaster could not have occurred. The original responsibility for the accident must therefore rest with the railroad company.

It is recommended that in all cases similar to the present, where work is to be done on a railroad bridge which involves the temporary removal of essential parts—such as rivets, bolts or members of any kind—or other weakening of the structure, one of the two following precautions be adopted:

First—That a competent inspector, appointed by and responsible directly and solely to the railroad company, be stationed at the bridge, whose duty it shall be to watch the progress of the work, and to inspect the condition of the bridge, so that he shall know at all times whether or not the bridge is in a safe condition for the passage of trains, and to signal approaching trains to stop or to reduce speed in case it becomes at any time necessary or prudent to do so. Or—

Second—That the bridge be supported by a temporary trestle sufficient to carry safely all trains while the work is in progress and until its completion.

No general rule can be laid down as to which of these precautions should be taken. Either ought ordinarily to be sufficient.

The second has this advantage: that when the bridge is supported on a trestle the work can be done in the manner most convenient and economical for the contractor, without having to guard against the temporary weakening of the structure and without reference to the passage of trains.

The first, as above phrased, supposes that the railroad company would not desire to divide with the contractor the responsibility for the due execution and completion of the work while it is still in progress, but would prefer to make it the duty of the inspector to keep himself advised at all times of the actual condition of the bridge as affecting the safety of trains, rather than to supervise and direct the manner of the execution of the work by the contractor.

The inspector may, of course, properly be charged with both of these duties if the contract so provides or allows. No additional recommendation is deemed necessary with respect to the speed of trains.

In cases where a bridge is in process of building or is undergoing general reconstruction or extensive repairs, the slowing of trains is necessary, and is required in general practice.

In cases like the present, however, with the adoption of either of the above precautions, the slowing of all trains at all times is not necessary, and therefore is not recommended.

In the present case, if there had been a sufficient trestle, the train would have passed safely over the bridge. If, instead of a trestle, there had been a competent inspector, the train would have been stopped.

REPAIRS ON THE AUSTIN DAM.

The following is the report made by Mr. J. T. Fanning to the Austin Board of Public Works on Sept. 21, regarding the progress of the work on repairs at the headgate end of the dam:

I have just inspected the excavation near the dam, which has been made by your engineer, Mr. Gorham P. Low, and find that he has made good and satisfactory progress since he assumed charge. The excavation shows loose material east of the headgates 30 ft. in width and extending from the surface soil down to a level 40 ft. lower than the surface of the water in the lake. The firm rock against which the gate masonry abutted ceased to be solid in a short distance east of the masonry and the character of the rock changed to a loose material for the 30 ft. mentioned. It was necessary to cut through all this loose material over the stratum over which the water flowed when it passed beyond the line of the headgates.

At this lower depth, 28 ft. lower than the level of the base of the headgate masonry, there was a soft stratum 2 ft. in thickness. This thin, soft stratum was scoured by the flowing water horizontally to a great width. The scour extended under the firm rock beneath the headgates and allowed that rock to settle. This was the cause of the crack in the masonry.

The excavation already made has cut across and to the bottom of the loose material above described, and the cut has been extended 40 ft. easterly into the undisturbed material of the east bank. The soft, thin stratum will be further cut by a tunnel excavation under the standing headgate masonry, extending to the masonry of the end of the dam, and the cut-off wall will thus be joined to the end of the dam.

All this excavation has been necessary to permit the building of the cut-off wall, as heretofore advised, and of sufficient depth and length to be thoroughly effective. This excavation has been made with good judgment, and it is now nearly ready for the building of the cut-off wall. The wall gives the best of promise of making the work tight and substantial. The thoroughness with which this work is being done and the connection of this cut-off with the end of the dam will permit us to reduce the quantity of masonry previously thought advisable in the extension of the wall at the north end of the power house. The excavation is now finished at the lowest depth and the laying of the concrete masonry there was commenced yesterday.

A novel type of bridge has recently been completed to connect the towns of Portugalete and Las Arenas, about ten miles from Bilbao, Spain. The structure consists of a skeleton platform carried by a suspension bridge resting on iron towers. Rails are laid on both the up and down stream sides of the platform, upon which runs a frame of friction wheels from which the ferry car is slung by cables. The ferry car is thus only a few feet above the water, in fact at the same level as the docks on the river banks, while the platform is of a sufficient height to permit the passage of large vessels. The car can be propelled by hand, steam or electric power as may be desired, but "Le Genie Civil," from which these details are taken, does not state the power used here. It is stated, however, that with 150 passengers the car traverses the span of over 500 ft. in one minute, and is entirely without oscillation. The total weight of the car and rolling gear is 40 tons. This bridge is the invention of M. de Palacio, a Spanish architect, and M. Arnodin, a French engineer.

An artesian well 650 ft. deep with a casing 10 ins. in internal diameter was recently put down two miles from San Bernardino, Cal., at a cost of $2,900, including labor, casings and all other material. The well is owned by Mr. Henry Warren, of San Bernardino, and was sunk by Geo. Renwick & Co., of San Francisco, Cal. Work was begun about June 14 and finished July 29, 1893.

The successive strata pierced were as follows:

Material.	Depth, ft.	Material.	Depth. ft.
Sand and gravel	120	Clay	52
Clay	50	Gravel	18
Gravel	40	Clay	16
Sandy clay	90	Gravel	34
Gravel	30	Clay	10
Sand and clay	118	Gravel	8
Gravel	28	Clay	16
		Gravel	20
Total			650

Water was struck at 448, 528, 562, 606 and 630 ft., but the quality or quantity of the various flows was not tested. The lower end of the casing is perforated. An examination of the well by Mr. J. T. Taylor, Riverside, Cal., for the purpose of making a report on it, showed the water rising about 4½ ins. above the top of the pipe, the estimated flow being about 600 gallons per min., 864,000 gallons per day, or about 1⅓ cu. ft. per sec. The temperature of the water is about 65° F.

Concessions for tramway lines in the city of Cairo, Egypt, are to be awarded on Feb. 1, 1894, and the government is advertising for tenders. Parties submitting bids are required to state full particulars as to the roadway which they propose to build and the equipment which they propose to furnish, and must also state what amount of annual compensation they will pay to the government and the rates of fare to be charged. Copies of the act of concession, giving full particulars, can be obtained by addressing the Minister of Public Works, Cairo, Egypt. Tenders are to be received at the same time for a narrow gage line from Manzomah to Menzaleh and Matarieh, with branches.

The resumption of hydraulic mining in California will eventually have some effect in increasing the country's available gold supply. Ten years ago, when hydraulic mining in California was at its height, a capital of from $100,000,000 to $200,000,000 was invested in the business. The injunctions secured by the residents of the river valleys prevented the hydraulic miners from discharging their debris into the streams, and practically all the mines were closed. In recent years a few of the more valuable workings have been reopened, the miners impounding the debris and not permitting its discharge into the streams. A bill, which became a law at the last session of Congress, provided for the appointment of a commission from the United State Engineer Corps to have jurisdiction over the impounding systems of hydraulic miners. Plans and specifications of proposed impounding systems must be submitted to the Commission, and receive its approval before construction; and the works themselves must be inspected and approved by the Commission before they can be used. Under this act it is believed that a large proportion of the gold-bearing placers in California can be profitably worked, and many schemes to that end are now in progress. The Commission in charge of the work is comprised of Col. G. H. Mendell, Lieut.-Col. W. H. H. Benyaurd, and Maj. W. H. Heur.

The Chesapeake & Ohio Ry. Co.'s annual report makes a good showing for the year ending June 30, 1893, in spite of competition in the coal traffic. The operating expenses were 69% of the gross earnings, and while the rate per ton per mile was less than that for the previous year, owing to the coal competition, yet the freight rate per ton per mile, exclusive of coal, shows a satisfactory increase. The average passenger receipts were 1.989 cts. per passenger-mile, and the average freight receipts were 5.11 mills per ton per mile, including coal, or 6.42 mills per ton per mile, exclusive of coal. The average load of freight cars was 14.2 tons, and freight trains averaged 20 loaded and 10 empty cars each. Considerable work was done in rail renewals with 75-lb. rails, and in double-tracking. The average results in locomotive performance were as follows:

Miles per pint of oil	17.27 miles
Miles per ton of coal	21.73 miles
Coal per engine mile	92.05 lbs.
Coal per pass.-car mile	14.67 lbs.
Coal per freight car mile	5.37 lbs.
Cost of motive power per pass.-car mile	3.22 cts.
Cost of motive power per freight car mile	0.85 ct.
Cost of motive power per mile run	16.66 cts.

A "straw bridge" is a curiosity described in the Texas newspapers. It is said to be built across the Red River 17 miles from Quanah, Hardeman Co., Tex. As described, the bed of this river is very wide and is a very fine, red, treacherous sand, making heavy hauling impossible. The bridge is really nothing but a causeway, 3 miles long,, about 5 ft. high, and wide enough for two teams. It was constructed by a near-by settler, who charges a small toll for its use. It is built of alternating layers of long grass and sand, and is rebuilt every season, as the high water washes it away. An attempt has been made to build an iron bridge, but it was washed away almost immediately, and the natives are said to find the straw bridge cheaper and better, as it is longer.

A sandstone monolith 110 ft. long, 10 ft. square at the base and tapering to 4 ft. square at the top was quarried last year by Mr. Frederick Prentice, the owner of a sandstone quarry near Ashland, on the south shore of Lake Superior. The cost of quarrying and cutting is said to have been about $15,000. Mr. Prentice offered the monolith to the Wisconsin World's Fair Commission, but as the estimates for removal and setting up at Chicago ranged from $25,000 to $90,000, the gift was refused, and the stone is now being cut up into building blocks.

The irrigation of the great basin of the Amou Daria River, the ancient Oxus, is said to have been determined upon by the Russian authorities. The soil is very fertile, and Prince Galitzin, now in the United States, is quoted as having stated that a system of canals and ditches, involving an expenditure of millions of dollars, has already been planned for this region.

A water-tube boiler used by Gurney in his steam carriage of 1830 is described and illustrated by a correspondent of "The Engineer" as of historical interest. This boiler had 12 sets of horizontal tubes, about 3 ft. 3 ins. long, and 8 or 9 ins in diameter, connected by U-tubes, with the lower tubes forming the grate. There were no vertical circulating tubes, but above was a larger tube which was the reservoir for steam and the ends of the 12 tubes, above and below, opened into two larger horizontal tubes placed at right angles to the sets of tubes, and connected at the ends by two large vertical tubes.

A new process of electric welding has been invented by Messrs. Lagrange and Hoho, two Belgian engineers, according to the "Schweizerische Bauzeitung." It is well known that if the two ends of a wire through which an electric current is being passed are immersed in water, the water is decomposed, bubbles of hydrogen gas being formed at one end and oxygen gas at the other end of the wire. If the current is quite strong the disengagement of hydrogen bubbles is so rapid at the cathode as to surround that end of the wire with a cushion of gas, which being a poor conductor becomes highly heated, and if the current is sufficient the metal soon melts. In practice in order to get energetic action at the cathode with a small current the anode is formed of a plate of sheet lead.

This is placed in a vessel of water rendered conducting by dissolving carbonate of soda in it, and the iron or other metal to be welded is held in the water, where it soon reaches a welding heat. It is stated that an iron bar 3 cm. square can be raised to a white heat by 100 amperes of current. A curious feature claimed for the process is that, owing probably to the absence of oxide due to the action of the nascent hydrogen evolved at the surface of the metal, which reduces it to a metallic state, metals never before welded can be easily joined. Thus copper and brass can be welded to iron, platinum and gold can be welded together, and platinum can be welded to many other metals, while pieces of hard cast iron can be welded together.

Damage claims amounting to $38,500, for deaths and injuries in the Toledo tunnel collision, which occurred about two years ago, have been paid by the Lake Shore & Michigan Southern R. R.

A 1¼-in. steam pipe burst on the U. S. cruiser "Montgomery" while being tested by the contractors on a preliminary trial trip, on Sept. 20, and Zachariah Mewshah, Chief Engineer of the Columbian Iron Works, of Baltimore, and a coal passer named Doyle were fatally scalded.

Street car accidents in Baltimore from May, 1891, when the first rapid transit line was inaugurated, to Sept. 21, 1893, resulted in the death of 18 persons and the injury of 65. Of the 18 killed, 10 have been killed since July 7, 1893. The cars are nominally limited to a speed of 10 miles an hour, and six miles per hour at street crossings, but actually they are run at much higher speeds.

The electric searchlight has been applied in pit sinking in Scotland. To enable the workmen to labor through the night a search light, which consisted of an arc lamp, a lens and a mirror, inclosed in a sheet iron case, was suspended over the pit's mouth. Access to the lamp was obtained by a sliding shutter on each side of the case. The light was focused or adjusted by a screw on the top of the outside of the case, and when necessary the lamp could be adjusted to diffuse light throughout the whole shaft, or be concentrated at the bottom. The mirror, which was hung on its centre, could be moved in a vertical direction, so as to deflect the rays of light to any required spot, and could be fixed in any position by a thumb-screw.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF AUGUST, 1893.

[Furnished to Engineering News by the Department of Agriculture.]

Stations.		Temperature. (Deg. Fahr.)				Wind.			Precipitation—rain and melted snow—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.	Total.	Heaviest in 24 hours.	No. of rainy days.
		Average	Max.	Min.	Range.	Average	Max.				
Northern Cities.	Northfield, Vt	64.6	91	36	55	7.4	33	W	6.14	1.56	17
	Portland, Me	66.8	90	53	37	7.6	40	SE	2.74	0.96	13
	New York, N. Y	74.4	93	58	35	9.6	54	SE	7.18	3.83	11
	Pittsburg, Pa	71.4	92	50	42	5.2	24	N	2.94	2.16	7
	Chicago, Ill	69.8	95	54	41	15.2	50	NE	0.18	0.16	2
	Omaha, Neb	71.4	94	45	49	5.9	34	SW	3.62	2.34	7
	St. Paul, Minn	69.0	97	43	54	6.7	34	SW	2.40	1.50	8
	Duluth, Minn	64.7	91	49	42	6.6	23	SW	1.51	0.82	6
	Bismarck, N. Dak	68.9	103	37	66	10.5	41	NW	0.67	0.53	5
	Average	69.0	94	47	47	8.3	37		3.04	1.54	8
Southern Cities.	Washington, D. C	....	..	..	..	5.8	..		....	....	..
	Louisville, Ky	76.6	95	57	38	6.4	23	NW	1.68	1.50	4
	St. Louis, Mo	76.1	93	57	36	7.9	35	NW	0.65	0.42	5
	Savannah, Ga	79.3	92	67	25	7.6	72	NE	12.59	5.61	21
	Leavenworth, Kan	72.8	94	46	48	5.3	30	SW	3.01	0.98	6
	Jacksonville, Fla	81.4	95	69	26	7.6	48	SW	10.02	3.62	19
	Chattanooga, Tenn	77.0	92	62	30	5.5	34	NW	4.18	1.56	11
	New Orleans, La	82.0	93	72	21	7.3	36	N	4.56	1.06	12
	Memphis, Tenn	78.8	96	60	36	5.7	42	SE	0.62	0.27	4
	Palestine, Tex	80.6	97	60	37	4.3	26	SE	3.55	1.01	8
	Average	78.3	94	61	33	6.3	38		4.51	1.78	10
Western Cities.	Helena, Mont	66.4	98	42	56	7.8	46	SW	0.46	0.46	1
	Port Angeles, Wash	56.7	81	42	39	6.3	24	W	0.05	0.04	2
	San Francisco, Cal	56.6	72	47	25	14.5	42	SW	0.00	0.00	0
	Salt Lake City, Utah	73.2	96	52	44	5.6	38	NE	0.71	0.34	7
	Denver, Colo	65.8	85	50	35	6.0	27	NE	5.12	2.02	17
	Yuma, Ariz	70.0	92	50	42	7.0	30	SW	0.35	0.24	6
	Santa Fé, N. Mex	91.0	111	67	44	7.0	32	SW	0.38	0.25	3
	Average	68.5	91	50	41	7.7	34		1.01	0.48	5

The pumping dry of Lake Angeline, near Ishpeming, Mich., to obtain access to the iron ore deposits underneath its bed, is completed as far as the water is concerned. There, however, remains a bed of semi-liquid mud from 2 ft. to 40 ft. deep which has to be removed and is likely to prove the most difficult portion of the work. This lake had an area of 160 acres and was about 70 ft. deep in the middle. The work of pumping was begun last spring before the snow left the ground, when a rotary pump with a capacity of 20,000 gallons per minute was anchored in a barge in the center of the lake, and began pumping water into a big flume elevated 20 ft. above the surface of the water. The pump has been going day and night, allowing for occasional breakdowns, and the water has only recently been drained all out. To remove the water in the mud large cylindrical tubes perforated with small holes are being forced into the mud, from which the water will be removed as it filters in. It is expected that it will take about 16 months to complete the work.

The proposed canal to connect Bordeaux with the Mediterranean, supplementing the old Languedoc Canal, would be 27 ft. deep, 140 to 200 ft. wide, and about 300 miles long. There would be 22 double locks, 600 ft. long and 80 ft. wide. The promoters of the scheme are asking from the French Government a concession for 99 years, and some financial assistance from the state.

CONSTRUCTION NEWS

RAILWAYS.

East of Chicago—Existing Roads.

BALTIMORE & CUMBERLAND.—It is reported that the $3,000,000 required to complete this road has been assured as soon as the present financial stringency is over, and it is thought that important contracts will soon be awarded. Ch. Engr., Chauncey Ives, Hancock, Md.

BALTIMORE & OHIO.—A dispatch to the Baltimore "Sun" from Salisbury, Md., states that the extension of this railway to Elkton, Chestertown, Easton and other places down the peninsula is being agitated by prominent business men in several of the counties.

BELLEFONTE CENTRAL.—This road will be opened for regular traffic in about two months, according to reports. The work of grading has been practically completed and track laid from near Bellefonte, Pa., to Hublersburg. There will be five iron girder bridges, all of which will be completed within a month.

CHICAGO & EASTERN ILLINOIS.—H. M. Porter, Chn. Ex. Com., is quoted as stating that it has been fully determined to build the proposed extension to the Ohio River by way of Mitchell, Ind.

LANCASTER, OXFORD & SOUTHERN.—Surveys have been made for an extension of this road from near Kingsbride Station, Pa., to Quarryville. Ch. Engr., A. M. Nevin, Oxford, Pa.

MICHIGAN.—Davis Bros., Detroit, are building 12 miles of railway from Midland, in Midland Co., north toward the Gladwin branch of the Michigan Central R. R. The grading is nearly all done, and tracklaying will be commenced in about a week. The road is owned by Hubbard & Dingwall & Co., Detroit, who own about 20,000 acres of valuable farming land near the upper terminus of the road, and it will be used to move about 100,000,000 ft. of hard wood timber into market, only one passenger train being run daily each way. Ch. Engr., Milo H. Davis, Detroit.

OTTAWA, ARNPRIOR & PARRY SOUND.—It is reported that the tracklayers will reach Renfrew next month and Eganville by the middle of November. Seven bids have been received for building the 10 miles from Indian Point, Golden Lake, to Killaloe, and the contract will soon be awarded. Application has been made for the bonus of $50,000 voted by the city of Ottawa to be paid when the road should be completed to Arnprior.

PENNSYLVANIA.—It is expected that work on the Roslyn branch will be resumed within a few weeks, and the line completed in about a month thereafter.

ROCKAWAY VALLEY.—The right of way is being obtained for an extension of this railway through Morris Plains to Morristown, according to reports, and it is thought the line will be built before spring. Supt. and Engr., J. E. Melick, White House, N. J.

WABASH.—Surveys are being made for a line between Defiance, O., and Montpelier, Ind.

WASHINGTON, WEST SHORE, BALTIMORE & DRUM POINT.—Van Aken & Hays, Washington, have been awarded the contract to complete the old Baltimore & Drum Point Ry. from Baltimore to Drum Point, a distance of about 80 miles. The contract includes grading, tracklaying, ballasting, stations and terminal yards at Drum Point. The road is now nearly all graded and the bridges built, and it is intended to have the line in operation by next January. The road will connect with the Annapolis, Washington & Baltimore R. R. about a half mile from Millersville, Md., the headquarters of Van Aken & Hays, the contractors.

Projects and Surveys.

GLADEVILLE.—The contract for grading 3⅛ miles of this projected dummy line from Ramsey Place, Va., on the Norfolk & Western R. R., to Wise C. H. has been awarded to Wing & Horneck, Johnson City, Tenn., the grading to be completed within six months. Pres., E. M. Fulton, Wise Court House, Va.

YOUGHIOGHENY & WICK HAVEN.—Incorporated in Pennsylvania to build a railway from Banning Station, on the Pittsburg, McKeesport & Youghiogheny R. R., to Wick Haven, a distance of one mile; capital stock, $18,000; Pres., Frank May, Girard, Pa.

Southern—Existing Roads.

ABBEVILLE SOUTHERN.—This railway has been completed from its southern terminus, about six miles from Dothen, Ala., on the Alabama Midland Ry., to Headland, a distance of about 15 miles, and it is expected that the entire line to Abbeville will be completed in about two months.

WILMINGTON, NEW BERNE & NORF[illegible].—This road has been completed to New Berne, N. C., and opened for regular traffic. The distance from Wilmington, N. C., is about 87 miles, of which about 75 miles have been in operation for several weeks.

Projects and Surveys.

COAL RIVER & ST. ALBANS.—This company is reported as ready to award contracts for building 50 miles of road (first division of 200 miles) from St. Albans to Madison or Boone C. H., W. Va. The grade will be 3 ft. to the mile and the line will follow the bank of the Coal River. The company was recently organized and purchased the franchise and charter of the St. Albans & Coal River R. R. Co., as stated in our issue of Aug. 24. Pres., M. P. O'Hern, Charleston, W. Va.

DAUPHIN ISLAND.—A press dispatch from Mobile, Ala., states that T. W. Nicol, Ch. Engr., Dauphin Island R. R. & Harbor Co., has received a cablegram from London to begin work on the proposed railway at once. The plan is to connect that city by rail with deep water in the Gulf of Mexico, 35 miles distant. The road has been projected for several years and is to run on the west shore of Mobile Bay to Cedar Point, cross Grant's Pass to Dauphin Island and thence to the south shore of the island. The secretary of war has recently approved the plans for a bridge over Grant's Pass. The plans also include four breakwaters.

NASHVILLE TERMINAL.—The city council of Nashville, Tenn., has passed on its final reading the bill granting this recently incorporated company the right of way along the west bank of the Cumberland River from South Nashville to the Lick Branch sewer, and the right to construct a tunnel under the east side of the public square. Jere Baxter and Thos. Parkes are among the incorporators.

Northwest—Existing Roads.

CENTRALIA & CHESTER.—It is reported that surveys have been made for an extension of this railway from Sparta, Ill., to a point opposite Genevieve, Mo., on the Mississippi River. Ch. Engr., H. W. Schmidt, Sparta, Ill.

DULUTH & IRON RANGE.—The profiles of the proposed extension of this railway to the Mesabi Iron Range show that the road will leave the main line about two miles south of Two Harbors and extend about 65 miles in a nearly air line to the range. Including branches there will be about 75 miles of construction and it is reported that contracts for some of the more heavy work will be awarded this fall. Ch. Engr., R. Angst, Duluth, Minn.

IOWA.—Hamilton Browne, Des Moines, and other owners of coal mines in Boone Co. are reported as building a short railway from the coal mines to connect with the Minneapolis & St. Louis Ry.

Projects and Surveys.

CHICAGO, SIOUX CITY & BISMARCK.—Incorporated in Illinois to build a railway from Chicago to Sioux City, Ia., thence through South Dakota, by way of Blue Blanket Valley, to Bismarck, N. Dak.; capital stock, $1,000,000; Ira Brown, Wheaton, Ill.; R. H. Beattie, B. F. Bell, D. H. Lee, Chicago; principal office, Chicago, Ill.

EAST ST. LOUIS & SOUTHERN.—There is a report that this company has leased the Cologne road and East St. Louis belt line, giving an entrance into East St. Louis, Ill., and that a line will be built at once to Prairie du Bon.

Southwest—Existing Roads.

SOUTHERN PACIFIC.—Work on the Midland branch of the Louisiana Western R. R. is progressing rapidly. This branch leaves the main line near Estherwood, La., and is 22 miles in length, as stated in our issue of July 20. About 16 miles have been opened up, of which 10 miles have been graded and are ready for the tracklayers. The only heavy work, according to reports, will be the crossing of Bayous Plaquemine and Jonas, forks of the Mermentau. The first of these will require about 1,600 ft. of bridging, and the other 600 ft. J. P. Hughes, Fort Worth, Tex., is the contractor, and E. B. Cushing the engineer in charge.

Projects and Surveys.

ST. LOUIS & KIRKWOOD.—Incorporated in Missouri to build a railway from St. Louis to Kirkwood, a distance of ten miles; capital stck, $100,000; John Pitman, G. W. Tausig and George L. Edwards, Kirkwood; J. Fruin, J. D. Houseman, St. Louis; principal office, St. Louis, Mo.

SUGARLAND.—Incorporated in Texas to build a railway from Sugarland, Fort Bend Co., to Arcola, a distance of 14.2 miles; capital stock, $142,000; E. H. Cunningham, G. M. Brackenridge, E. B. Cunningham, San Antonio; W. D. Cleveland, E. W. Sewall, Houston; G. B. Miller and others, Sugarland. In our issue of Aug. 3 we stated that the contracts for a railway between these two places, according to reports, had been awarded to McSweeny Bros., the distance by a typographical error being given as eight miles instead of 14.

Rocky Mt. and Pacific—Existing Roads.

CANADIAN PACIFIC.—It is reported that bids are being received by Harry Abbott, Gen. Supt., Vancouver, B. C., for grading ten miles of the Arrow Lake branch from Revelstoke south. The right of way is now being cleared.

HELENA, WHITE SULPHUR SPRINGS & CASTLE.—Work on this road is progressing rapidly. The grading of the first eight miles east from Helena, Mont., is about completed, and it is expected that an additional six miles will be graded by Nov. 1. The Illinois Steel Co. is making the rails, but as there are a large number of small bridges to be built and considerable rock-work to be done, it is probable that no track will be laid until spring. R. A. Harlow, the promoter of the road, is reported as confident that the line will be in operation to White Sulphur Springs within a year. Further information of the proposed road was given in our issue of Aug. 31.

NELSON & FORT SHEPPARD.—Tracklaying has been resumed on this road, and it is expected that the line will be completed between the international boundary line and Nelson, B. C., in six weeks. It is stated that there is not an idle man in that part of the country who wants work but can get it.

OREGON.—The J. G. & I. N. Day Contracting Co. is building two miles of standard gage railway at Cascade Locks to transport stone from the quarries to the locks.

SOUTHERN PACIFIC.—It is stated that the mortgage recently drawn up by this company to secure the new issue of bonds contains specifications of 18 new lines, aggregating 721 miles in length. Some of these are now in course of construction, and many of them have been projected for several years, with slight prospect of being built in the near future. Nearly all are in the southern half of California, and the most important is probably that one now being built from San Luis Obispo to Santa Barbara, to form a continuous line from Los Angeles to San Francisco, up the coast. The different lines are as follows:

Beginning at Kings City, Monterey Co., easterly to Lewis Creek, Monterey Co., 15 miles.—Paso Robles, San Luis Obispo Co., southeasterly to Carisso Plains, 56 miles.—San Luis Obispo southeasterly to the Santa Ynez River, at Santa Ynez Mission, Santa Barbara Co., 80 miles.—At or near the mouth of the Santa Ynez River, southeasterly through Lompoc to Santa Ynez Mission, 35 miles.—San Buenaventura, Ventura Co., easterly to Hueneme Plains and San Fernando Valley to Los Angeles, 70 miles.—Ontario, San Bernardino Co., southeasterly through Chino and South Riverside to Elsinore, Riverside Co., 41 miles.—San Bernardino, southerly through Colton and Riverside to South Riverside, 8 miles.—Declez, in San Bernardino Co. to Declezville, 3 miles.—Redlands Junction, easterly through Redlands and Crafton to Yucaipa Valley, San Bernardino Co., 15 miles.—San Bernardino, southerly to Motor Junction, 8 miles.—Collis, Fresno Co., easterly to Fresno, 16 miles.—Mendota, Fresno Co., southeasterly through Fresno, Kings and Kern counties, to Lokern, Kern Co., 110 miles.—Lokern, easterly to Rio Bravo, 16 miles.—Stevens, Kern Co., easterly to Bakersfield, 15 miles.—Lokern, southeasterly to Asphalto, 10 miles.—Stevens, southerly through Sunset Asphaltum Beds, and thence in a general easterly and northerly direction to Pampa, 56 miles.—Fresno, northeasterly through Pollasky, on the San Joaquin River, to near the head of the San Joaquin River in Madeira Co., 75 miles.—Montpelier, Stanislaus Co., easterly and northerly to the Yosemite Valley, Mariposa Co., 92 miles.

UTAH & WYOMING.—The Salt Lake City "Tribune" states that Al. Thompson, one of the men interested in this railway, has returned from Coalville, and reports that the grade from the coal mines to the connection with the Utah Central Ry. is complete, and ready for the track. They have 60,000 ties ready to lay, and hope to have a road from the mines to the Utah Central completed before winter sets in.

Projects and Surveys.

COLUMBIA RIVER & ASTORIA.—There is a report that contracts have been awarded for this proposed railway, referred to in our issue of Aug. 31. D. K. Warren, Astoria, Ore., and Walter C. Smith, Portland, Ore., are interested.

SAN DIEGO, YUMA & PHOENIX.—Work on this road has been suspended. About 3½ miles of track have been laid, and the road graded considerably farther, according to reports, but the company has been unable to raise the expected funds by subscription or by other means..

SAN FRANCISCO & ATLANTIC.—This company, which was incorporated about a year ago to build a railway between San Francisco and Los Angeles, has filed for record in San Joaquin Co. a mortgage for $20,000,000, according to reports. Frederick Homer, the projector of the road, is reported as stating that the road will surely be built, and a part of it next year.

STREET RAILWAYS.

ABINGTON, MASS.—The directors of the Rockland & Abington Electric R. R. Co. have voted to increase the capital stock from $60,000 to $120,000 and to extend the line as far as South Weymouth this fall. Extensions to East Weymouth, Hingham and Nantasket are also under consideration.

BRAINTREE, MASS.—The Braintree Ry. Co. has commenced the construction of the street railway between South Braintree and Holbrook. It is reported as the intention of the company to extend the line to Quincy to connect with the Quincy St. Ry.

MELROSE, MASS.—It is reported that the Lynn & Boston St. Ry. Co. will soon change the motive power of the line through this town to electricity.

TEWKSBURY, MASS.—The Lowell & Reading St. Ry. Co. has petitioned for a franchise in this town, M. L. Hamblett stating in behalf of the petitioners that the road would be built if a charter was obtained.

WELLESLEY, MASS.—The selectmen have offered a franchise for an electric railway through the town and connecting with Natick and Newton to the Natick & Cochituate Electric Ry. Co.

BUFFALO, N, Y.—Work on the Buffalo, North Tonawanda & Sanborn Electric R. R. will be commenced within a few days, and it is expected to have the line completed in December. Several new bridges will be required, including one over the Tonawanda Creek at Tonawanda, to cost at least $10,000. The power plant will be located near Bergholtz, and the road will be laid with 60-lb. rails. Both passengers and freight will be carried. Pres., L. F. W. Arend; Treas., E. G. Reisterer, Tonawanda.

MIDDLETOWN, N. Y.—The Middletown & Goshen Traction Co. has secured consent to operate its proposed road, including the use of T rails, through the town of Wallkill to the town of Goshen.

PATERSON, N. J.—The contract for the Grand St. Electric Ry. from the Little Falls road to Railroad Ave. and Market St. has been awarded to Reid & McKibben, the work to be completed in 40 days.

PLAINFIELD, N. J.—The Plainfield St. Ry. Co. will soon commence work on an extension of its electric railway to Dunellen, according to reports, the next extension to be to Netherwood.

CARLISLE, PA.—The Cumberland Valley Electric Passenger Co., noted in our issue of Sept. 14 as incorporated, is reported as to build its proposed road at once. Pres., O. H. Ormsby, Pittsburg; Gen. Man., S. R. Ickes, Altoona.

NORRISTOWN, PA.—The contract for extending the Norristown Passenger Ry. to West Conshohocken has been awarded to George N. S. Brubaker, Lancaster.

PITTSBURG, PA.—The Allegheny Traction Co. will soon use electric motive power, according to reports, and form a direct connection with the Allegheny, Millvale & Sharpsburg Electric Ry., making a continuous line between the Baltimore & Ohio station in this city and Main St. in Sharpsburg.

SCRANTON, PA.—A charter has been granted to the North Scranton Transit Co.; capital stock, $50,000; J. H. Fellows, A. Weinschenk, J. G. Eisele and others.

YORK, PA.—Surveys have been made for the proposed York & Dover Electric Ry. and as soon as the right of way is secured the construction will be commenced, according to reports.

WILMINGTON, DEL.—The Wilmington City Ry. Co. is preparing to extend its road to New Castle, five miles distant, also to make extensions in this city.

BALTIMORE, MD.—The Canton, Sparrows Point & North Point R. R. Co. has been incorporated to build an electric railway from Canton to North Point, a distance of 10 or 12 miles; capital stock, $500,000; F. W. Wood, Pres. Maryland Steel Co.; Jos. B. Foard, T. W. Blakistone, W. B. Brooks, Jr., Baltimore; Maj. L. S. Bent; Pres. Pennsylvania Steel Co., Steelton, Pa.—Thos. B. Gatch, Pres. Baltimore, Middle River & Sparrows Point Electric Ry. Co., is reported as stating that all the right of way has been secured for the proposed railway except that through the property of the Canton Co.

BELAIR, MD.—The Hughes & Rigby Co., Baltimore, which has the contract for lighting this city, is reported as investigating the advisability of building an electric railway between this place and Havre de Grace.

NORTH BALTIMORE, O.—J. J. Geghan has been granted a franchise for the proposed street railway to Weker, 2¼ miles distant, and the construction will be commenced at once, according to reports.

TOLEDO, O.—A press dispatch states that the Ohio & Michigan Electric Ry., Light, Power & Heat Co. will be organized this week to build the electric railway to Detroit, recently noted in these columns. The right of way has been nearly all secured, and it is expected that the line will be built as far as to Monroe, Mich., this fall. The company intends to run trains every half hour between this city and Detroit, and to carry passengers, express and light freight; capital stock, $1,000,000; L. K. Parks, J. H. Ainsworth, Ellery Eaton, J. H. Dawson, Toledo; H. J. Warner, New York.

ADRIAN, MICH.—Samuel D. Nesmith, the promoter of the proposed electric railway between this city and Ypsilanti, is reported as saying that the company has purchased the electric railway in this city and will have control after Oct. 1, and also the line connecting Ypsilanti and Ann Arbor. The road will connect Adrian, Tecumseh, Clinton, Macon, Saline, Ann Arbor and Ypsilanti. It will be 62 miles in length, which makes the building of 42 miles of new track necessary. The franchises and rights of way have all been secured. Power houses will be built at Tecumseh, Saline, Ypsilanti and in this city.

ALTON, ILL.—The Alton Electric St. Ry. Co. will soon sell bonds for $100,000, according to reports.

ATCHISON, KAN.—The Atchison Electric Light & Power Co., recently incorporated, has awarded the contract for changing the motive power of the street railway, which it has purchased, from mule to electric power to the Great Western Mfg. Co., Chicago and Duluth, at $225,000. The contract is reported as including the building of 10½ miles of new track and putting in an electric light plant, the railway to be in operation by March 12, 1894.

OAKLAND, CAL.—The supervisors of Alameda Co. will receive bids until Oct. 30 for an electric railway.

HIGHWAYS.

NEW JERSEY.—The city council of Cape May has voted to advertise for bids for rebuilding the road to Mount Vernon.

MISSOURI.—The city council of Hannibal has directed the engineer to prepare estimates for a gravel road from the city to Oakwood.

BRIDGES.

BUFFALO, N. Y.—The department of public works will receive bids until Oct. 5 for a deck plate girder bridge over Scajaquada Creek.——The Buffalo, North Tonawanda & Sanborn Electric R. R. Co. will require several bridges on its proposed line, including one at Tonawanda to cost at least $10,000. Pres., L. F. W. Arend.

EASTON, PA.—Bids will soon be asked for widening the Third St. Bushkill bridge, according to reports; estimated cost, $18,000 to $20,000.

MOBILE, ALA.—Plans have been approved by the secretary of war for a bridge to carry the proposed railway of the Dauphin Island R. R. & Harbor Co. over Grant's Pass at the entrance of Mobile Bay, and it is reported that the construction will soon be commenced. T. W. Nichol, Ch. Engr.

COVINGTON, KY.—As soon as the financial condition has sufficiently improved it is expected that steps will be taken to construct the proposed bridge.

LOUISVILLE, KY.—A press report states that the new bridge across the Ohio River at this place is to be completed as rapidly as possible. Work was suspended after the completion of the piers and one approach three years ago, but recently the Cleveland, Cincinnati, Chicago & St. Louis Ry. secured control of the property, and will use the bridge for an entrance to this city. Forty bridge builders arrived Sept. 21 from Phoenixville, Pa., to begin the construction of the iron work.

KANSAS CITY, KAN.—The county commissioners are considering the construction of a new bridge across the Kaw River at Turner. It is proposed to request bridge companies to submit plans, together with bids, for the complete construction. The work will probably be done this fall.——The experts recently employed to examine the James St. bridge have reported that the bridge is unsafe for general traffic. It will not be closed for travel, however, until the contract is awarded for a new structure.

WATER-WORKS.

ROCKLAND, ME.—The contract for laying about five miles of mains has been awarded to Dacey & Taylor, Skowhegan, according to reports.

MEDFORD, MASS.—Bids are asked until Oct. 2 for finishing basin No. 1, at Spot Pond. E. W. Hayes, Clk. Comrs.

NEWBURYPORT, MASS.—The city is negotiating with Percy M. Blake, Hyde Park, for plans for municipal works.

SPENCER, MASS.—Nathan E. Craig has reported in favor of a 150,000-gallon stand-pipe; estimated cost, $5,000.

QUINCY, MASS.—The residents of Ward 6 have petitioned the council for an extension of the service into that district.

WEST BRIDGEWATER, MASS.—A town meeting is proposed to vote on the acceptance of the act permitting the town to issue bonds for $60,000 for a supply.

COHOCTON, N. Y.—The citizens have voted in favor of the issue of bonds for $22,500 for works.

DOLGEVILLE, N. Y.—It is stated that 17 bids were received for constructing the proposed works, recently noted in these columns, the lowest being about $64,000. W. H. Bacon, Secy. Bd., informs us that those of H. S. Evelin & Son, Waterford, and Inman Bros., New York, have been held for consideration, but that the contract has not yet been awarded.

MADRID, N. Y.—It is reported that works will be put in.

SYRACUSE, N. Y.—Bids are asked until Oct. 6 for 4 to 36-in. cast iron pipe, also for trenching and pipe-laying, as stated in our advertising columns. James B. Brooks, Secy. Bd.

CLAYTON, N. J.—Moore Bros., who recently sank seven successful wells at their glass works, have offered a supply to the town provided the borough will build a stand-pipe.

ALTOONA, PA.—C. A. Martin, Secy., writes us that no bids were received Sept. 19 for the proposed reservoir owing to an injunction served by the Continental Construction Co., New York. Some months ago the contract was awarded to this company, but it was afterward declared null by the council and the work ordered readvertised.

BETHLEHEM, PA.—The Morea Water Co. has been incorporated; capital stock, $5,000.

M'DONALD, PA.—The Citizens' Water Co. has been incorporated by Richard Gladden, McDonald; J. M. Shaffer, Slippery Rock; J. A. Duncan, Hulton.

PHILADELPHIA, PA.—The mayor has approved the plan of the director of public works recommending the construction of storage dams on the Perkiomen and Tohickon creeks, the whole, including $11,500,000 for aqueduct, estimated to cost about $19,000,000.

PITTSBURG, PA.—The directors of the Monongahela Water Co. have ordered another $100,000 of the increase in capital stock, voted last June, to be collected to pay for the extension through the Chartier's Valley and the new pumping station at McKee's Rocks. Temperanceville will be supplied from this plant through a 1-in. main running from Sheridan through Elliott borough. It is reported that the supply will be from infiltration wells being constructed under the bed of the river.

JACKSONVILLE, FLA.—The city council is considering a proposition to issue bonds for $1,000,000, of which $225,000 would be for extending the water mains.

GLENVILLE, O.—The citizens are reported as stongly in favor of erecting a pumping station in the village, and it is thought that an election will soon be held to vote on an issue of bonds for $50,000 for this purpose. The present supply is from Cleveland.

HILLSBORO, O.—It is reported that William G. Moler, Springfield, will begin the construction of works here Oct. 1.

LOCKLAND, O.—The contract for mains has been awarded to D. R. P. Dimmick & Co., Newport, Ky., at $19,541.

MASSILLON, O.—The Massillon Water Supply Co. has been incorporated; capital stock, $200,000. The Massillon Water Co., built works here in 1885, under a 20-year franchise.

PLAIN CITY, O.—Bids are asked until Oct. 20 for $30,000 of 6% water-works and electric light bonds. George E. Kilbury, Clk.

BROWNSTON, IND.—It is reported that works are being discussed.

NEW HAVEN, IND.—The town has voted, 101 to 19, in favor of works, which will be put in at once.

LAKE ANN, MICH.—Efforts are being made to organize a water-works company, according to reports.

NILES, MICH.—The citizens have voted in favor of $32,000 of bonds for works.

EVANSTON, ILL.—The council has passed a resolution looking to the immediate addition of a 12,000,000 gallon pumping station and additional mains, at a total cost of about $200,000. The mayor is reported as opposed to the project.

JOLIET, ILL.—The council is considering an issue of bonds for $100,000 for extensions to secure better fire protection.

SAVANNA, ILL.—Preparations are being made to extend the mains 3,800 ft. A 1,000,000-gallon pump has recently been purchased.

SOUTH MILWAUKEE, WIS.—The citizens have voted, 289 to 22, in favor of issuing bonds for $40,000 for works.

MAPLETON, IA.—The contract for works is reported to have been awarded to J. W. Smith & Co., Sioux City, at about $10,000.

MANKATO, MINN.—The council is considering the purchase of a 3,000,000 to 5,000,000-gallon pump. An additional reservoir is also proposed.

GRAND ISLAND, NEB.—Plans are being considered for 17 additional wells and a 3,000,000-gallon pump. It is proposed to issue $10,000 of bonds this fall and $10,000 more in the spring for larger mains.

NORTH BEND, NEB.—The proposed works are estimated to cost $5,416, according to reports.

MADISON, S. DAK.—E. Sheridan, Cy. Aud., wishes bids for the purchase of $25,000 of 20-year 5% bonds to be issued to put in works. The supply will be from wells and pumped to a stand-pipe. The contract will not be let probably until January; estimated cost, $30,000; population, 3,000.

NEVADA, MO.—Important improvements are being considered by the water company, according to reports.

ST. LOUIS, MO.—The following bids have been received for two 10,000,000-gallon pumping engines: Groshon High Duty Pumping Engine Co., New York, $223,000; Edward P. Allis Co., Milwaukee, $132,000; Southwark Foundry & Machine Co., Philadelphia, $220,300; Rankin & Fritch Foundry & Machine Co., St. Louis, $173,000; Holly Mfg. Co., Lockport, N. Y., $198,000; Henry R. Worthington, New York, $155,000; engineer's estimate, $200,000.

VANDALIA, MO.—An election has been called to vote on an issue of bonds for works and a committee appointed to contract for an artesian well.

LITTLE ROCK, ARK.—It is reported that a plant will soon be put in for residents of the north side.

FLORESVILLE, TEX.—The citizens are reported as negotiating with an engineer for plans for works.

TYLER, TEX.—The Tyler Water Co. will soon begin work on improvements to cost $50,000, according to reports.

NEW WHATCOM, WASH.—The transfer of the works from the Bellingham Bay Water Co. to the city was made Sept. 18, the company accepting $150,000 for bonds in payment for the plant.

SPOKANE, WASH.—D. M. Whiting has offered to sell his plant to the city and to connect it with the city's mains for $3,000.

GRANT'S PASS, ORE.—The Grant's Pass New Water, Light & Power Co. has been incorporated; capital stock, $30,000; Pres., P. H. Harth; Secy., E. C. Dixon; Treas., W. Jackson. Works were built here about three years ago by the Grant's Pass Water, Light & Power Co., under a 50-year franchise.

PORTLAND, ORE.—The contract for submerged pipe across the river has been awarded to the Oregon Bridge Co., at $79,855, the ball and socket joint to be used and the work completed by Nov. 1, 1894.

OAKLAND, CAL.—The special committee on a new supply is considering plans for works to be owned by the city. The present works were built in 1886 by the Contra Costa Water Co.

OCEANSIDE, CAL.—Homer Laughlin, Liverpool, O., is reported as having examined the headquarters of the San Luis Rey with a view to taking the water to supply this city and adjacent places, this city offering a bonus of $30,000. The present supply is pumped from the river.

SANTA BARBARA, CAL.—The Santa Barbara Water Co., has offered to sell its entire property to the city for $275,000; all this side of the Santa Ynez Mts. for $260,000, or all on this side except the De la Guerra plant for $215,000, and the committee has recommended that the latter proposition be accepted, the payment to be made in 40-year 6% bonds.

SUMMERLAND, CAL.—H. L. Williams is arranging to secure a gravity supply for the town.

HEDLEYVILLE, QUE.—The municipality of Limoillon has contracted with De Lavalle & Co., Montreal, for works, the cost not to exceed $55,000, according to reports.

BEETON, ONT.—It is reported that works will be put in at a cost of $12,000.

CHATHAM, ONT.—The city is reported as negotiating with the New York Filter Co. for a filter plant.

KINGSTON, ONT.—Bids are asked until Oct. 2 for $13,000 of 30-year 4½% water-works bonds. F. C. Ireland, Cy. Treas.

WINNIPEG, MAN.—The engineer employed to report on improving the works has recommended improvements estimated to cost $200,000, including a water-tower and filter bed with an area of two acres.

ARTESIAN WELLS.

LA FAYETTE, O.—The council has decided to sink two more wells for fire protection.

THOMPSONVILLE, MICH.—The village is reported as about to issue bonds for $2,500 for three wells.

GREENVILLE, TEX.—The local papers are urging the sinking of one or more artesian wells.

IRRIGATION.

NEW COMPANIES.—Rio Grande Dam & Irrigation Co., Las Cruces, El Paso and Juarez, N. Mex.; $5,000,000; E. C. Roberts, E. V. Berrien, J. L. Campbell, E. Kern, Phoebus Freudenthal, J. H. Riley, Sol. Schultz, A. W. Loomis, L. Bradford Prince.——La Huerta Co., Eddy, N. Mex.; $100,000; to irrigate lands at and about La Huerta, Lower Pecos Valley; C. B. Eddy, F. Dominice, W. H. Ellice, C. C. Blodgett, W. A. Hawkins.

SEWERS.

AMHERST, MASS.—The selectmen have approved plans for the proposed extension of the sewer in Sunset Ave. 6,000 ft. through the grounds of the agricultural college, whence the college will convey the sewage to the north end of the farm where settling tanks will be placed and the sewage experimented with to determine its value as a fertilizer, the state having made an appropriation to the college for this purpose.

LAWRENCE, MASS.—The special committee has voted to recommend that bonds for $50,000 be issued so as to begin work at once on proposed sewers.

WOBURN, MASS.—Over 100 men have signified their desire to work on the proposed sewers, according to reports, and the construction may be commenced this fall.

PROVIDENCE, R. I.—The department of public works is preparing to ask for bids for about two miles of trunk sewer. The work will be let in four sections and will require more than 6,000,000 brick. A pumping station will be located at the southern terminus, which will be 30 ft. below the outfall sewer. Plans for the station and engine will soon be prepared by the city engineer, the engine probably being of about 70,000,000 gallons capacity.

JAMESTOWN, N. Y.—Bids are asked until Oct. 3 for constructing about 45,000 lin. ft. of tile sewers. Robt. Bryan, Secy. Bd. Pub. Wks.

TROY, N. Y.—The lowest bids received for sewers in three streets were those of J. H. Cavanaugh, aggregating $28,174.

ERIE, PA.—The question of issuing bonds for $125,000 for an intercepting sewer is to be again submitted to a vote of the people.

MEADVILLE, PA.—Plans for a complete system have been prepared by Samuel M. Gray, Providence. The total cost, including pumping station and contingencies, is estimated at $108,658.

ATLANTA, GA.—The council has voted to construct an 8 to 24-in. pipe sewer in several streets.

JACKSONVILLE, FLA.—The council is considering a proposition to issue bonds for $1,000,000, of which $175,000 would be for sewers, $150,000 for paving, $75,000 for an electric light plant and $25,000 each for bulkheading streets along the river front and for park improvements.

COVINGTON, KY.—Bids are asked until Oct. 10 for 3,825 lin. ft. of 9 to 12-ft. brick sewer, average cut 8 ft.; estimated cost, $92,000. Thos. H. Kennedy, Cy. Engr.

CLEVELAND, O.—The board of control has approved plans for the Walworth Run sewer. It will be 13,400 ft. long and 6 ft. 3 ins. in diameter at the beginning, and 12 ft. 6 ins. where it empties into the river. There will also be several tunnels, according to reports, from 40 to 50 ft. below the surface.

MIDDLETOWN, O.—The council has decided to issue bonds for $20,000 for sewers and street improvements, subject to a vote of the people.

NILES, O.—It is reported that the council is taking steps to commence the construction of the proposed system.

MILWAUKEE, WIS.—The right of way is being secured for a sewer to drain the northwestern portion of the city. It will be 10 ft. in diameter and built in tunnel, according to reports.

SIOUX CITY, IA.—Bids are asked until Oct. 10 for about a mile of brick sewer, payment to be made in 2 to 5-year 6% bonds. K. Sunde, Chn. Com.

KANSAS CITY, MO.—Sewer ordinances are under consideration by the council for work estimated to cost over $200,000.

MONTREAL, QUE.—Bids are asked until Oct. 4 for sewers in five streets. P. W. St. George, Cy. Surv.

STREETS.

QUINCY, MASS.—The residents of Ward 6 have petitioned that at least $20,000 be appropriated at once to raise the causeway in that ward.

SALEM, MASS.—The contract for building the Harmony Grove St. has been awarded to H. Scott Tuttle, Swampscott, at the price given last week.

DEPEW, N. Y.—The Depew Improvement Co. is about to contract for 7½ miles of sidewalks.

GREENBUSH, N. Y.—The contract for improving Riverside Ave., has been awarded to Hilt & Johnson, at about $10,000.

TROY, N. Y.—The lowest bid for improving Canal Ave. was that of J. H. Cavanaugh, at $11,497.

CAMDEN, N. J.—The committee is considering the paving of Fourth St., from Penn St. north.

CHESTER, PA.—The council has voted to pave West Ninth St. with brick.

BALTIMORE, MD.—Bids are asked until Oct. 2 for grading and paving Fairmount Ave., between Patterson Park Ave. and Luzerne St. A. E. Smyrk, Cy. Comr.

ATLANTA, GA.—The council is considering ordinances for paving two streets at an estimated cost of about $21,000.

CINCINNATI, O.—The board of administration will receive bids until Oct. 16 for paving with brick and granite blocks; Oct. 17 with brick, and until Oct. 21 for paving two streets with brick.——Resolutions have been adopted for brick paving to cost $20,941, and asphalt paving to cost $55,724.

OTTUMWA, IA.—Bids are asked until Oct. 2 for paving Second St. with brick. A. W. Buchanan, Chn. St. Com.

PALESTINE, TEX.—Bids are asked until Oct. 2 for 50,000 sq. ft. of stone, cement or asphalt sidewalks, and 12,500 lin. ft. of stone or brick curbing. W. C. Campbell, Cy. Secy.

KINGSTON, ONT.—The city will spend $12,000 in laying granolithic walks, according to reports.

TORONTO, ONT.—The following contracts have been awarded: Chas. Farquhar, paving with concrete and granite, $19,185; E. M. Cathro, similar work, $16,187; J. H. McKnight & Co., paving with brick, $29,367.

ELECTRIC LIGHT AND POWER.

SUNCOOK, N. H.—The selectmen have been authorized to contract for electric street lighting for ten years.

LAWRENCE, MASS.—The council is considering an order for the establishment of a municipal electric light plant.

WALDEN, N. Y.—The trustees are reported as investigating the question of electric street lighting.

CANONSBURG, PA.—Efforts are being made to secure an electric light plant at this place, according to reports.

NORRISTOWN, PA.—Bids are asked until Oct. 25 for an electric light plant for the state hospital for the insane in this city. W. A. Drysdale, Consult. Engr., 20 Hale Building, Philadelphia.

SALISBURY, MD.—R. W. and W. T. Johason, Dover, Del., have purchased water power privileges and the fixtures of the electric light plant which was burned last May, and will put in a new plant for both arc and incandescent lighting.

MILLEDGEVILLE, GA.—Bids are asked until Oct. 17 for lighting the city for six or more years. P. L. Fair, Cy. Clk.

SAVANNAH, GA.—The mayor is reported as stating that the legislature will be petitioned for authority to put in a municipal electric light plant for both public and private purposes.

ARCANUM, O.—There is talk of putting in an electric plant at this place.

NAUVOO, ILL.—H. C. Reiner, Keokuk, Ia., is reported as trying to secure an electric power franchise to develop water power at this place.

FOX LAKE, WIS.—The parties who built the creamery are canvassing the town with a view to putting in an electric light plant, according to reports.

MONTICELLO, MINN.—The citizens are contemplating putting in an electric light plant, according to reports.

LITTLE ROCK, ARK.—Only one bid was received for the proposed extension of the municipal electric light plant, and the board decided to postpone action for several weeks; estimated expense, $36,000.

NEW COMPANIES.—Atlantic Electric Mfg. Co., Brooklyn, N. Y.; $100,000; W. P. Freeman, A. T. Schlichting, Julius Smith.——Mecosta Electric Co., Big Rapids, Mich.; $25,000; to operate the franchise granted to C. E. Wilson, Chicago, some months ago.——Aurora Electric Light & Power Co., Aurora, Mo.; $20,000; E. L. Foster, M. T. Davis, W. T. Branham.——West Chicago Light & Power Co., Chicago, Ill.; $60,000; F. T. Barber, Grove E. Walter, Charles J. Bussie.——Metropolitan Electric Co., Chicago, Ill.; $300,000; E. S. Elliott, J. E. Campbell, Henry A. Ritter.

CONTRACT PRICES.

SEWER BRICK.—Washington, D. C.—A contract for sewer brick has been awarded to the Childs Brick Co., at $7 to $9.20 per M, according to place of delivery.

BRICK PAVING.—Poughkeepsie, N. Y.—The contract for paving Cannon St. has been awarded to Homer & Co., Olean, at $2.10 per sq. yd. for Syracuse brick.

PIPELAYING.—Boston, Mass.—The contract for laying the 6-in. iron pipe connecting Long and Moon Islands, through which both islands will be supplied with water from the city proper, has been awarded to John Cavanaugh & Co., at 83 cts. per ft.

ELECTRIC LIGHT PLANT.—Linwood, O.—The contract for an electric light plant has been awarded to the Commercial Electric Co., at the following prices: Alternating incandescent and constant current arc system, $7,200; 40 arc lamps, $965; convertors for 400 16-c. p. lamps, $550; 408 16-c. p. lamps, $165; 400 key sockets, $70. Geo. Hornung, Engr.

SEWERS.—Albany, N. Y.—The following bids have been received for a brick and cement sewer in Madicon Ave., the contract being awarded to R. H. Strong: Wm. F. Doyle, 507 ft. 28-in. circular brick drain with 8-in. walls, $4 per lin. ft.; 455 ft. 24-in. drain, 8-in. walls, $4; 234 ft. 20-in. vitrified pipe sewer, $1.75; 5 manholes, $65 each; 93 ft. relaying 18-in. vitrified pipe sewer, 85 cts. per lin. ft.; 14 Y branches on 20-in. sewer, $5.50 each; 9 ft. 10-in. slants with vitrified covers, 72 cts. each; 9 ft. 10-in. bends, 95 cts. each; 100 ft. 10-in. pipe, 75 cts. per lin. ft.; 69 ft. 6-in. slants, 55 cts. per lin. ft.; 162 ft. 6-in. bends, 65 cts. each; laying 1,400 ft. 6-in. vitrified pipe, 45 cts. per lin. ft. excavating 1,300 ft. of trenches, 50 cts. per lin. ft.; digging 40 ft. of house drain connections, 25 cts. per lin. ft. Robert H. Strong bid for the same work, respectively, $3.67, $3.57, $1.65, $54, 65 cts., $4.98, 72 cts., 89 cts., 62 cts., 45 cts., 53 cts., 33 cts., 40 cts., 18 cts.

LOCK GATES.—Detroit, Mich.—Bids have been received by Col. O. M. Poe, U. S. Engineer Office, for the gates for the 800-ft. lock, St. Mary's Falls Canal, the bidders being: 1, Willard S. Pope, Detroit, $182,609; 2, Chicago Ship Bldg. Co., Chicago, $199,271; 3, Riter & Conley, Pittsburg, $218,250; 4, King Bridge Co., Cleveland, $224,617; 5, Detroit Dry Dock Co., Detroit, $291,732; 6, John P. McGuire, Cleveland, $244,023. The work is given in this order: A, soft steel, 2,404,657 lbs., per lb.; B, forged and high steel, 119,168 lbs.; C, cast steel, 36,167 lbs.; D, cast iron, 3,665 lbs.; E. phosphor or alumin bronze, 5,322 lbs.; F. oak planks and cushions, 7,215 ft. B. M., per M. ft.; G, pumps, fittings as specified.

	1.	2.	3.	4.	5.	6.
A..	$0.059	$0.0728	$0.0675	$0.07	$0.093	$0.079
B..	.2725	.13	.37	.42	.485	.3767
C..	.0925	.11	.107	.08	.13	.096
D..	.06	.064	.094	.045	.093	.08
E..	.35	.375	.626	.30	.5175	.45
F..	60.00	100.00	87.59	50.00	75.00	70.00
G ..	2,100.00	1,470.00	3.446.10	1,000.00	1,500.00	2,100 00

WATER-WORKS.—Linwood, O.—Contracts have been awarded as follows: Addyston Pipe & Steel Co., 118 tons 10-in. pipe, 120 tons 8-in., 180 tons 6-in. and 11 tons 4-in., at $23 per ton, and 27 tons specials, at $45. Bourbon Copper & Brass Co., 40 fire hydrants with or without secondary valves, $42.50 or $30.50, respectively; 10-in. valves, 3, $22.80; 8-in., 13, $17.80; 6-in., 52, $11.10; 4-in., 4, $7; 68 valve boxes, $2.95. H. Merigold, laying 4,025 ft. 10-in. pipe, 19 cts.; 12,200 ft. 8-in., 18 cts.; 8,900 ft. 6-in., 14¾ cts.; 1,000 ft. 4-in., 13 cts.; setting 10, 8, 6, 4-in. valves, 19, 18, 14¾, 13 cts., respectively; setting hydrants, $5; laying 70 ft. 8-in. pipe for connecting elevated tank with pump-main, 18 cts.; 125 ft. 10-in. pipe connecting tank with reservoir, 20 cts.; 50 cu. yds. dry wall masonry, $2.50. Laidlaw-Dunn-Gordon Co., two horizontal compound duplex pumping engines, $4,087; vertical engine for 8-in. tube well, $336; for 6-in. well, $226; one 6 × 4 × 6-in. duplex feed pump, $118. L. Schreiber & Sons Co., elevated tank, $3,209. I. & E. Greenwald Co., power machinery and steam plant, $5,400. Geo. Hornung, Engr.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

STEAM ROLLER.—Pleasant Ridge, O.—Bids are asked until Oct. 2 for a steam roller. F. D. Acomb, Vil. Clk.

BONDS.—Cincinnati, O.—Bids are asked until Oct. 20 for $150,000 of bowlder pavement bonds. D. W. Brown, Cy. Aud.

IRON FENCE.—Buffalo, N. Y.—Bids will be received by the department of public works until Oct. 5 for an iron fence around the new reservoir.

CITY HALL.—Paterson, N. J.—Bids are asked until Oct. 25 for a city hall, as stated in our advertising columns. Walter Beveridge, Secy. Comn.

SEA WALL.—Salem, Mass.—Bids are asked until Oct. 2 for building a sea wall and the street extending from Congress St. to East Gardner St. S. S. Merrill, Comr. of Sts.

BREAKWATERS.—Mobile, Ala.—Press reports state that the Dauphin Island R. R. & Harbor Co. will soon construct four breakwaters, as stated in another column under Railways. T. W. Nichol, Ch. Engr.

LEVEE WORK.—New Orleans, La.—Bids will be received at the U. S. Engineer office until Oct. 9 for seven contracts, and until Oct. 10 and 11 for four contracts at each date. Captain John Willis, U. S. A.

PUMPING PLANT.—Seattle, Wash.—Moran Bros. Co., of this city, has been awarded the contract for the pumping plant for the United States dry dock at Port Orchard. The work includes three centrifugal pumps, 158,000,000 gallons capacity, and the price is stated as about $70,000.

INDUSTRIAL NOTES.

THE GILBERT CAR MFG. CO., Troy, N. Y., is considering plans for reorganization and resuming work. Henry C. Hale, Philadelphia, and William Kemp, Troy, are members of the committee.

THE MOUNT VERNON CAR MFG. CO., Mount Vernon, Ill., has a contract for 300 fruit cars for the Florida Central & Peninsular Ry. The cars are to be of 60,000 lbs. capacity, and equipped with air brakes and automatic couplers.

CARLILE & WEITBREC, Pueblo, Colo., railway and general contractors, have dissolved partnership. James N. Carlile and Lou F. Carlile have withdrawn from the firm, and the business will hereafter be conducted by R. F. Weitbrec.

THE ILLINOIS STEEL CO. will resume work Oct. 2 at five mills at Bayview, Milwaukee, according to the reported statement of C. S. Otjen, Superintendent. Employment will be given to from 1,200 to 1,500 men, who will work full time and receive the same pay as before the shutdown.

THE MIAMI VALLEY FUEL GAS CO., Piqua, O., has contracted with the Laidlaw-Dunn-Gordon Co., Cincinnati and Hamilton, for two cross compound Corliss engines with compound gas compressors; also for feed pumps, heaters, condensers and pipe work. The sizes of the engines and compressors are 22-in. and 40-in. steam cylinders and 16-in. and 32-in. gas cylinders, all 48-in. stroke. These compressors are used for taking the gas from the wells and forcing it through the lines to the various towns that are supplied by the company. The plant will be erected at Fort Recovery, O.

GEORGE E. NYE, Chicago, has a very complete exhibit of his improved steam vacuum pumps at the World's Fair, in Machinery Hall, Section 26, Aisle K 34, with D. D. Randall in charge. The following pumps are on exhibition and in working order: No. 1, capacity 50 gallons per min.; No. 2, 200 gallons per min.; No. 3, 300 gallons per min.; No. 4, 500 gallons per min.; No. 5, 800 gallons per min.; No. 6, 1,000 gallons per min. These pumps are adapted to all kinds of work where muddy or gritty water is encountered, and for well-sinking, irrigating or hydraulic mining, or for any work in connection with general contracting.

NEW COMPANIES.—Davy Steam Sewer Ditching & Mfg. Co., Chicago, Ill.; $250,000; John Dierk, William Davy, E. J. Davy.——Bipower Car Motor Co., Chicago, Ill.; $1,000,000; Harvey S. Park, O. W. Bond, S. E. Hibben.——Standard Smokeless Furnace Co., East St. Louis, Ill.; $150,000; P. B. Weston, W. B. Farr, Oscar Goosberg.——Chilled Gear Wheel Mfg. Co., Chicago, Ill.; $250,000; E. A. Rohrkaste, W. H. Hamilton, Carrell Gough.——Acme Track Jack Co., Chicago. Ill.; $60,000; J. J. Barkley, H. M. Anderson, R. A. Wilkerson.——Linwood Pressed Brick Co., St. Louis, Mo.; $30,000; Daniel McAllister, W. H. Hardy, D. B. Drummond, W. A. Miller.——Cole Chain Radial Dredge Co., Chicago, Ill.; $150,000; A. C. Conway, O. Knapp, S. F. Flaherty.——Progressive Power Co., Jersey City, N. J.; $300,000; J. H. Pratt, Montclair; F. G. Wheeler, E. F. Leeds, New York.——Consumers Oil Co., Jersey City, N. J.; $100,000; illuminating gas and fuel oil; A. L. Page, Stanley; W. F. Donthirt, Columbus, O.——Economic Gas Co., Seattle, Wash.; $500,000; J. H. Elder, S. N. Ford, G. R. Couls.

SANITARY DISTRICT OF CHICAGO.

SPECIAL NOTICE TO CONTRACTORS.

Notice is hereby given that the special contract made on Aug. 30, 1893, with McArthur Brothers' Company, for the completion of river diversion work on Sections 2, 3 and 4 of the Main Channel of this District, IN NO WAY AFFECTS OR HAS ANY BEARING ON THE RELETTING OF THE SAID SECTIONS now being advertised, bids for which are to be opened on Oct. 4, 1893.

THE SANITARY DISTRICT OF CHICAGO,
By FRANK WENTER,
President of its Board of Trustees.
Attest: THOS. F. JUDGE,
Clerk of the Sanitary District of Chicago.
Chicago, Sept. 6, 1893. 37-3t

Proposals for Excavating.

SANITARY DISTRICT OF CHICAGO. —TO CONTRACTORS.

Sealed proposals addressed to the Board of Trustees of the Sanitary District of Chicago and indorsed

"Proposal for Excavating a Portion of the Main Drainage Channel" will be received by the Clerk of the said Sanitary District at Room H, Rialto Building, Chicago, Ill., until 12 m. (standard time) of Wednesday, the 4th day of October, 1893, and will be publicly opened by the said Board of Trustees at the regular meeting held that day or at a special meeting called for that purpose.

The work for which the said tenders are invited is the excavation of that portion of the main drainage channel for the said Sanitary District, between Willow Springs and Joliet, Ill., known as contract sections two (2), three (3) and four (4), and consists in all of about 1,484,800 cubic yards of rock, of about 2,179,500 cubic yards of earth, the building of about 76,466 cubic yards of dry rubble walls.

Each of said sections will be treated as a separate contract in canvassing the proposals and making awards. As all awards will be made by individual sections, each bidder must make prices for each section separate and distinct from every other.

Each proposal must be accompanied by a certified check or cash to an amount equal to $3,000, multiplied by the number of sections bid upon.

All certified checks must be drawn on some responsible bank doing business in the city of Chicago, and be made payable to the order of the Clerk of the Sanitary District of Chicago. Said amount of $3,000 for each section will be held by the Sanitary District until all of said proposals have been canvassed and contracts awarded and signed, the return of said check or cash being conditioned upon any bidder to whom an award of any portion of said work may be made appearing within ten days after notice of such award being given, with bondsmen, and executing a contract with the Sanitary District for the section or sections of said work so awarded, and giving a bond satisfactory to said Board of Trustees for the fulfillment of the same in the amount of $100,000 for each section of work awarded him.

All proposals must be made upon blank forms furnished by the Sanitary District and must give the price for each separate item of work.

The bids will be compared on the basis of the engineer's approximate estimate of quantities, which will be furnished with copies of the specifications.

No proposal will be considered unless the party making it shall furnish evidence satisfactory to the Board of Trustees of his ability to do the work, and that he has the necessary pecuniary resources to fulfill the conditions of the contract, provided such contract shall be awarded him.

Bidders are required to state in their proposals their individual names and places of residence in full.

Specifications and plans may be seen at the office of the Chief Engineer, Rialto Building, Chicago, Ill.

The said Board of Trustees reserves the right to reject any and all bids.

THE SANITARY DISTRICT OF CHICAGO,
By FRANK WENTER,
President of its Board of Trustees.
Attest: THOMAS F. JUDGE, Clerk.
Chicago, Ill., Aug. 5, 1893. 32-8t

PROPOSALS FOR SUBMARINE CABLE.—U. S. Engineer Office, Willets Point, N. Y., Aug. 28, 1893.—Sealed proposals in duplicate will be received at this office until 12 m., on Monday, the 2d day of October, 1893, and opened immediately thereafter in presence of bidders, for about $33,000 worth of submarine insulated cable, single and multiple. Specifications, instructions to bidders, and blank forms will be furnished on application to this office. W. R. King, Lieutenant Colonel, Corps of Engineers, U. S. A. 36-4t.

CAST IRON WATER PIPE AND SPECIAL CASTINGS.

SEALED PROPOSALS will be received at the office of the Syracuse Water Board, City Hall, Syracuse, N. Y., until 2 o'clock p. m. of the 6th day of October, 1893, for furnishing and delivering on platform cars in the City of Syracuse:

200 tons (of 2,000 lbs.) of 36-inch cast iron straight pipe.

20 tons (of 2,000 lbs.) of 30-inch cast iron straight pipe.

16 tons (of 2,000 lbs.) of 24-inch cast iron straight pipe.

195 tons (of 2,000 lbs.) 20-inch cast iron straight pipe.

320 tons (of 2,000 lbs.) 16-inch cast iron straight pipe.

5 tons (of 2,000 lbs.) of 12-inch cast iron straight pipe.

5 tons (of 2,000 lbs.) of 10-inch cast iron straight pipe.

5 tons (of 2,000 lbs.) of 6-inch cast iron straight pipe.

1 ton (of 2,000 lbs.) of 4-inch cast iron straight pipe.

85,000 lbs. cast iron special castings.

The delivery of the pipe and specials must commence in fifteen days from the execution of the contract and be fully completed by Dec. 15, 1893.

The successful bidder will be required to execute the contract with the required surety in the sum of two thousand dollars in five days after notice that the work has been awarded to him.

Blank forms of contract, proposals, bond and specifications can be obtained at the Engineer's office of the Syracuse Water Board, 510 Bastable Block, in said city, on application.

Proposals should be indorsed "Tenders for Water Pipe" and be addressed to the undersigned.

JAMES B. BROOKS,
Secy. Syracuse Water Board.
Syracuse, N. Y., Sept. 20, 1893. 39-1t

TO BRIDGE BUILDERS.

SEALED PROPOSALS will be received at the City Clerk's Office, Binghamton, N. Y., up to 7 o'clock p. m., Oct. 16, 1893, for the finishing and erecting complete the sub and superstructure of the new bridge over Pierce Creek, City of Binghamton, N. Y. Bids for sub and superstructure each separate or together will be received. Bidders will furnish plans and strain sheets for superstructure. Specifications for superstructure, also plans and specifications for substructure, are on file in said City Clerk's Office. Proposals must be accompanied by check of $1,000, certified by Binghamton Bank, as a guarantee of good faith, and that bidders will enter into a contract within five days if awarded the same. The city reserves the right to reject any or all bids.

S. E. MONROE, City Engineer.
L. SEYMOUR, City Clerk. 39-2t

PROPOSALS FOR SEWER CONSTRUCTION.

SEALED bids for building a storm water sewer on 12th, 13th, Dale and 17th streets will be received by the City Clerk of Sioux City, Iowa, until 8 o'clock p. m. Tuesday, Oct. 10, 1893.

There will be about 1,200 feet of 3 ft. 4 inch, 300 feet of 4 ft. 6 inch, and 3,300 feet of 6-foot brick sewer and about 500 feet of 12, 15 and 18-inch pipe sewer, about 50 brick inlets and 15 manholes.

Plans can be seen and specifications and bidding blanks can be obtained at the office of the City Engineer.

A bond in the sum of 40% of the amount bid, with two acceptable sureties, one to be a resident of Sioux City, must accompany each bid.

Payment will be made in "Sewer Bonds" running two, three, four and five years, bearing interest at the rate of 6%.

The right is reserved to reject any or all bids.

(Signed) KNUDE SUNDE,
38-3t Chairman Sewer Committee.